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Technology Review

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AIR SAFETY IN JEOPARDY



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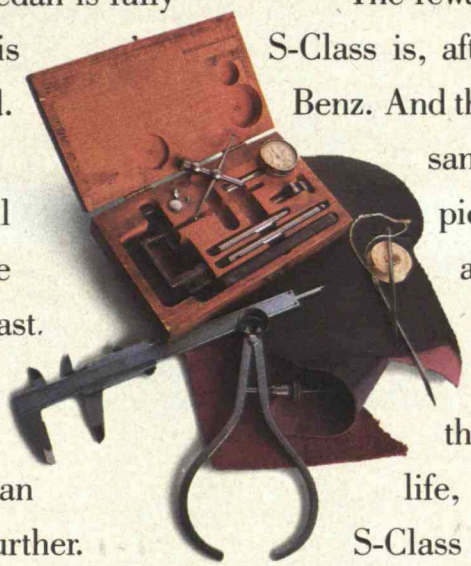
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MANY AUTOMOBILE MAKERS ITCH TO BUILD THE PERFECT CAR. THE MERCEDES-BENZ S-CLASS IS PROOF THAT SOME SIMPLY ITCH MORE THAN OTHERS.

It is a curious fact that not everyone who seeks the very best in a large sedan is fully aware of just how much sedan this entitles today's buyer to demand.

Some still opt for the overbearing "luxury" sedan in all its bulk and ostentation, unaware that big today can also mean fast, agile and responsive. Somewhat better off are those who have moved up to vivid big-sedan performance – but then go no further.



Then there are those who choose the sedans of the S-Class. The Mercedes-Benz overview is their overview: a large sedan– sufficiently well engineered – can *balance* triple-digit performance with hushed driving ease. Agile handling with an unruffled ride. The fragrance of leather upholstery and the richness of handworked woods with the tactile pleasures and keen precision of a true driver's car.

And the rewards that follow are theirs to enjoy every mile: swift and surefooted automotive travel on vast highways and unpaved byways alike. Experienced amid sumptuously comfortable surroundings. And in a blissful state of near silence.

The rewards continue–because the S-Class is, after all, built by Mercedes-Benz. And thus is welded, brazed, filed, sanded, polished and nit-picked to completion along an assembly route lined with enough inspections (and inspectors) to make this the most demanding trip of its life, if not any car's life. The S-Class aims not only for the glamour of high technology but also the reassurance of high technological reliability. And reflects almost fifty years of basic Mercedes-Benz safety research and engineering.

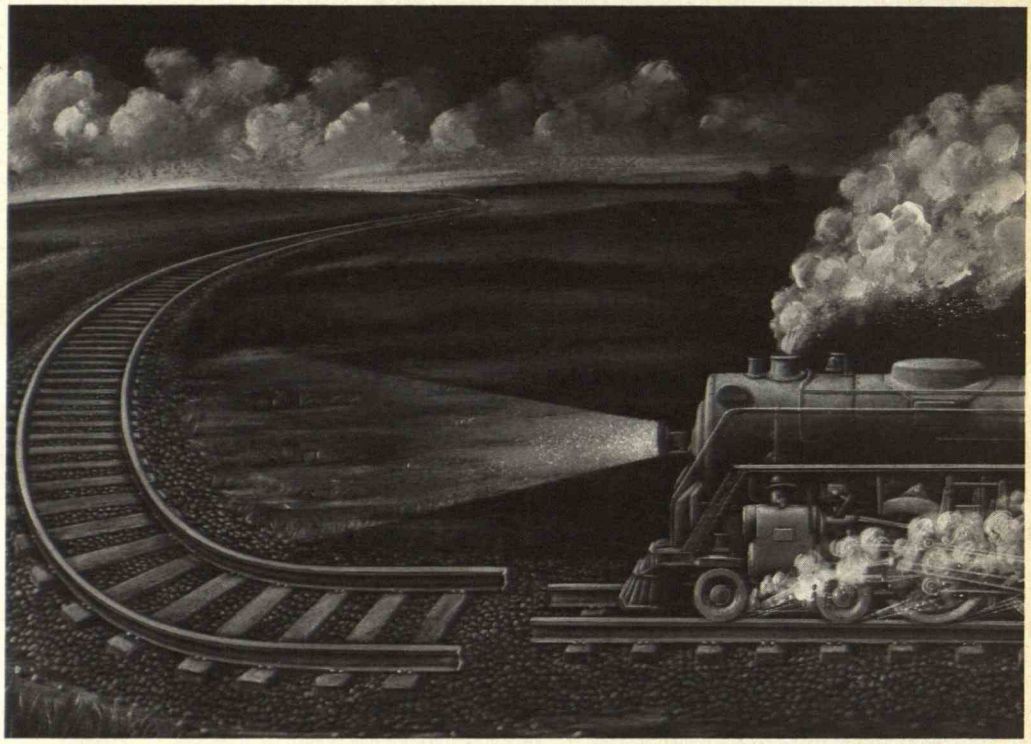
You can choose from three S-Class sedans–the 560 SEL and 420 SEL V-8's, and the stunning six-cylinder 300 SDL Turbo. Their character subtly differs from one to another; their blend of high performance and high driving civilization differs from all other large sedans in the world.

Engineered like no other car in the world

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Issues of the Information Age:

The way beyond Babel.



Imagine trying to build a railroad system if every locomotive manufacturer used a different track gauge. Every local stretch of railroad had its own code of signals. And in order to ride a train, you needed to know the gauges and the signals and the switching procedures and the route and the conductor's odd pronunciation of the station names.

The business of moving and managing information is in a similar state today. Machines can't always talk to each other. Proprietary systems and networks abound, with suppliers often jockeying to make theirs the de facto standard. The enormous potential of the Information Age is being dissipated by incompatibility.

The solution, as we see it, is common standards which would allow electronic systems in one or many locations to work together. People will be informed and in control, while the systems exchange, process, and act on information automatically.

AT&T is working with national, international, and industry-wide organizations to set up comprehensive, international standards to be shared by everyone who uses and provides information technology. We think it's time for everyone in our industry to commit to developing firm, far-reaching standards. The goal: to provide our customers with maximum flexibility and utility. Then, they can decide how and with whom to work.

We foresee a time when the promise of the Information Age will be realized. People will participate in a worldwide Telecommunity through a vast, global network of networks, the merging of communications and computers. They'll be able to handle information in any form—conversation, data, images, text—as easily as they make a phone call today.

The science is here now. The technology is coming along rapidly. But only with compatibility will the barriers to Telecommunity recede.

Telecommunity is our goal. Technology is our means.℠

We're committed to leading the way.

AT&T

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TechnologyReview



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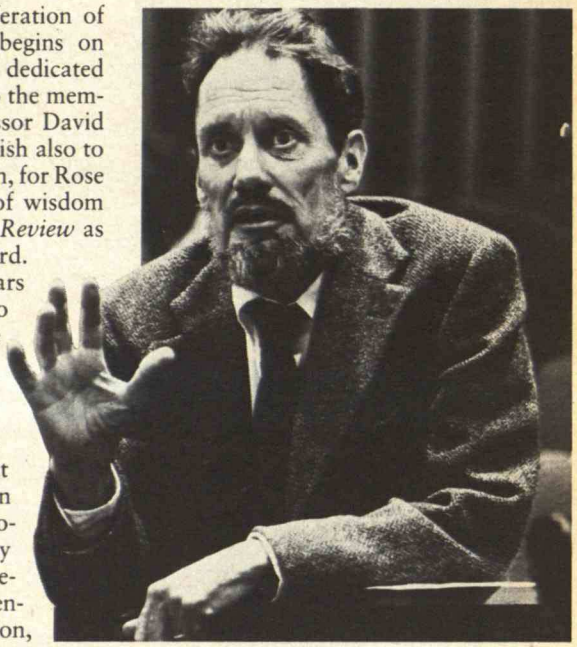
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FIRST LINE

FROM THE EDITOR

Ethical Dimensions of Technology



THE article on the proliferation of nuclear weapons that begins on page 68 of this issue is dedicated by its author, Marvin Miller, to the memory of his late colleague Professor David J. Rose of M.I.T. The editors wish also to be identified with that dedication, for Rose was for many years a source of wisdom and inspiration to *Technology Review* as a member of our Advisory Board.

After devoting the first 20 years of his professional career to plasma physics, to which he made notable contributions through both teaching and research, Rose in 1970 turned his efforts in a radical new direction. He became first a student and ultimately also an expert in the complex questions of how society chooses to use technology and the implications of those decisions. Rose first worked on energy resources and consumption, but he soon expanded his interest to encompass such issues as the management of nuclear waste, the proliferation of nuclear weapons, and the environmental impacts of technical developments.

Rose's approach to such questions was truly interdisciplinary. His understanding of social institutions and human psychology seemed as keen as his knowledge of science and technology, and he especially emphasized the interconnectedness of technology-related decisions. Consider, for example, Rose's work with two colleagues shortly before his death in 1985 on the potential of energy conservation to lower the rate of carbon-dioxide increase—and hence the increase of temperature—in the upper atmosphere. The general principle is obvious: CO_2 is released to enter the atmosphere whenever fossil fuels are burned. Reducing fuel consumption will therefore reduce CO_2 release and thus slow climate change that results from the "greenhouse effect." The importance of this work was its emphasis—consistent in most of Rose's analyses—on quantitative study of a problem that is usually studied only in qualitative terms. The conclusion: energy conservation practiced worldwide by both developing and developed countries could halve "the global energy requirement per unit of production or service in less than 50 years." Such a major reduction would have large-scale economic advantages while significantly affecting atmospheric CO_2.

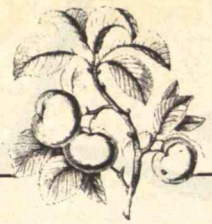
To his studies of such contemporary problems, Rose brought powerful ethical as well as technical and social dimensions that led ultimately to his role as host of the World Council of Churches' conference on "Faith, Science, and the Future" in 1979.

In that same year Rose was described by his M.I.T. faculty colleagues as "a deeply concerned and deeply knowledgeable human being struggling to anchor our evolution into the future on a firm basis of scientific truths, a thoughtful recognition of the contemporary state, and adequate consideration of the interests of future generations."

Technology Review is proud to identify with that agenda, and our highest aspiration for the magazine and its authors is to fulfill it as well as David Rose did.

John I. Mattill

PHOTO: M.I.T. MUSEUM



Herbicide Toxicity

NEW HERBICIDES

Charles M. Benbrook and Phyllis B. Moses provide some misleading information in "Engineering Crops to Resist Herbicides" (*November/December 1986, page 54*). First of all, they claim that since some of the new broad-spectrum herbicides inhibit enzymes specific to plants, animals face little or no risk. But herbicides can act on biochemical pathways in non-target species. The only way to determine whether a herbicide is safe is to carry out the appropriate animal testing.

Also, contrary to the authors' suggestion that broad-spectrum herbicides are safer than older ones, the evidence presented in the chart on page 57 indicates that they are much the same in terms of acute toxicity. More to the point, the chart should not have focused on acute toxicity in the first place: the acute toxicity of all these products is similar to that of table salt and ethyl alcohol. Any real problem would center on chronic toxicity of carcinogenicity.

Nor should the chart have implied that broad-spectrum herbicides are used at lower rates. Glyphosate is occasionally used at the rate given (0.5 pounds an acre), but the average rate is something like 2 pounds an acre—about the same as atrazine or alachlor. Moreover, even when the products are used at low rates, they do not necessarily "break down rapidly into carbon, nitrogen, and oxygen in the environment." For example, chlorsulfuron used on wheat can cause difficulties in potatoes or onions planted in the same soil as much as two years later.

When the authors suggest that the market for glyphosate would expand if crops could be made resistant, they overlook a major limitation of this herbicide: it kills only weeds that have already appeared. This total lack of residual effect would always be a major limitation.

Finally, while herbicides commercialized within the last few years have probably been tested more thoroughly than older ones, there is not a large body of satisfactory experience with the new ones. It is erroneous to assume that testing procedures, no matter how rigorous, will identify every possible adverse effect of a product.

R.I. MATELES
R.I. FREUDENTHAL
Westport, Conn.

The writers are, respectively, vice-president for research and director of product safety at Stauffer Chemical Co.

The authors respond:

We agree that all herbicides should be tested to determine their toxicity to non-target species. And we also agree with Mateles and Freudenthal's observation about acute toxicity. However, based on data in files at the Environmental Protection Agency, the active ingredients that account for over 60 percent of all agricultural herbicides are confirmed animal carcinogens. Detailed examination suggests that, in general, the older chemicals present by far the greatest carcinogenic risks.

We are aware that there is no connection between the rates at which herbicides are used and the rates at which they break down in the environment. But we note that glyphosate breaks down rapidly, while sulfonylureas and imidazolinones are more persistent.

Glyphosate is a very safe product in a market with several less-safe products. We expect the price of this herbicide to fall appreciably. If it does—and if new patterns of tillage and crop rotation convert glyphosate's current disadvantages into advantages—its use could rise.

ENGINEERING AT HARVARD

In "A Good Technologist Is a Noble Work" (*January 1987, page 16*), Samuel C. Florman is mistaken in saying that an anti-technology bias predominates at Harvard, or did in the 350th anniversary celebration. That observance featured more than a hundred symposia at which many faculty and a few administrators spoke. In the sciences, colloquia topics ranged from the origins of the universe to contemporary issues in technology, including artificial intelligence and materials science.

Over the past several years, Harvard has strengthened the engineering sciences and technology, and we expect to continue. Graduates of Harvard's programs in applied science are playing major roles in the development of technology. The university has become a partner in a new center for engineering research. And of the nine Harvard students receiving Presidential Young Investigator awards this year, three of them were studying engineering and a fourth was studying computer science.

Though committed to scholarship and teaching in the humanities, Harvard does not disdain science, applied science, and technology. The truth is that the university would like to do all these things—and others—well.

K. MICHAEL SPENCE
Cambridge, Mass.

K. Michael Spence is dean of the College of Arts and Sciences at Harvard University.

COMPUTERS AND DISABILITY

In "Making Computers Accessible to Disabled People" (*January 1987, page 52*), Frank Bowe states that "commercial speech-recognition systems now cost

Continued on page 8

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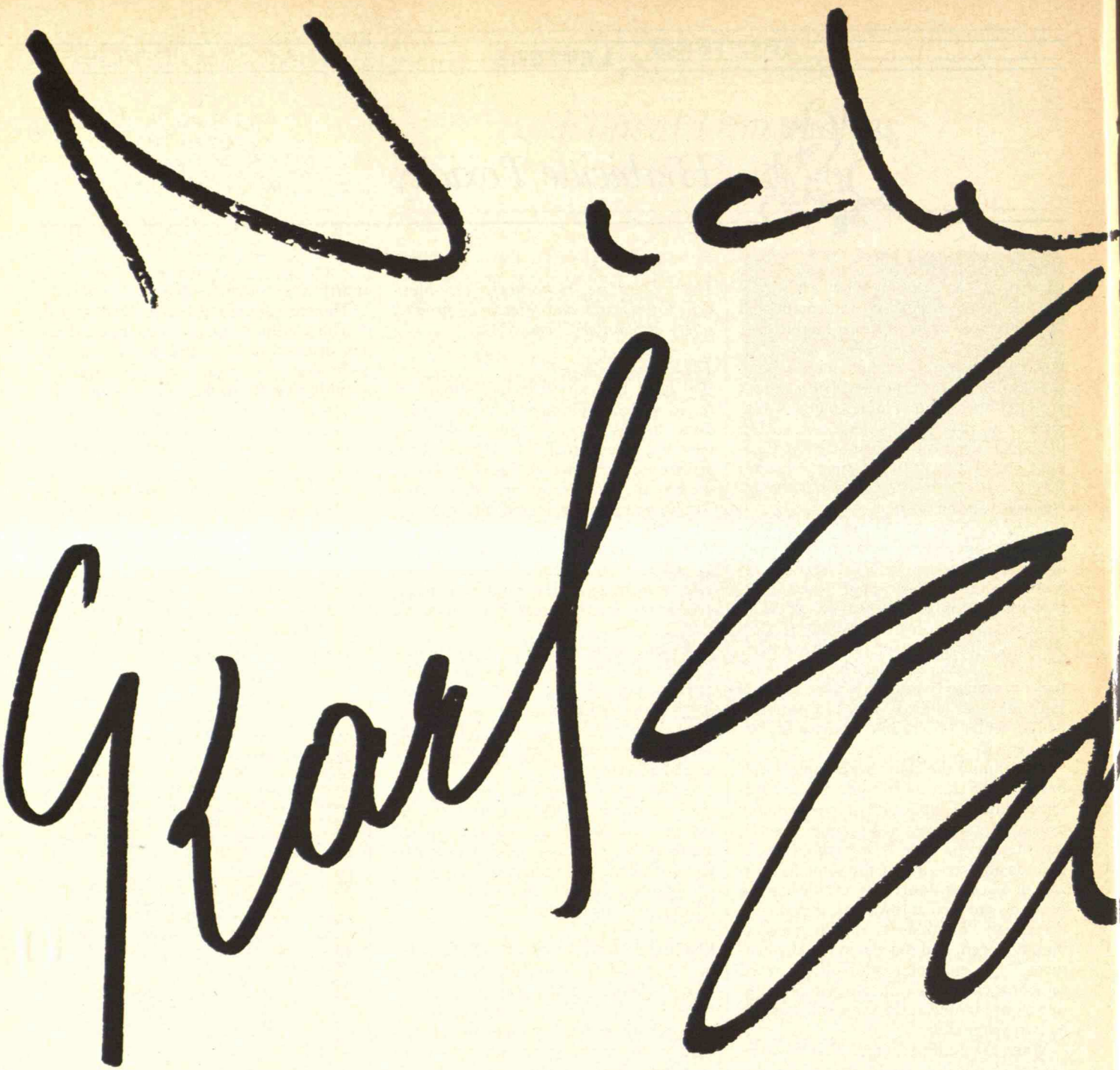
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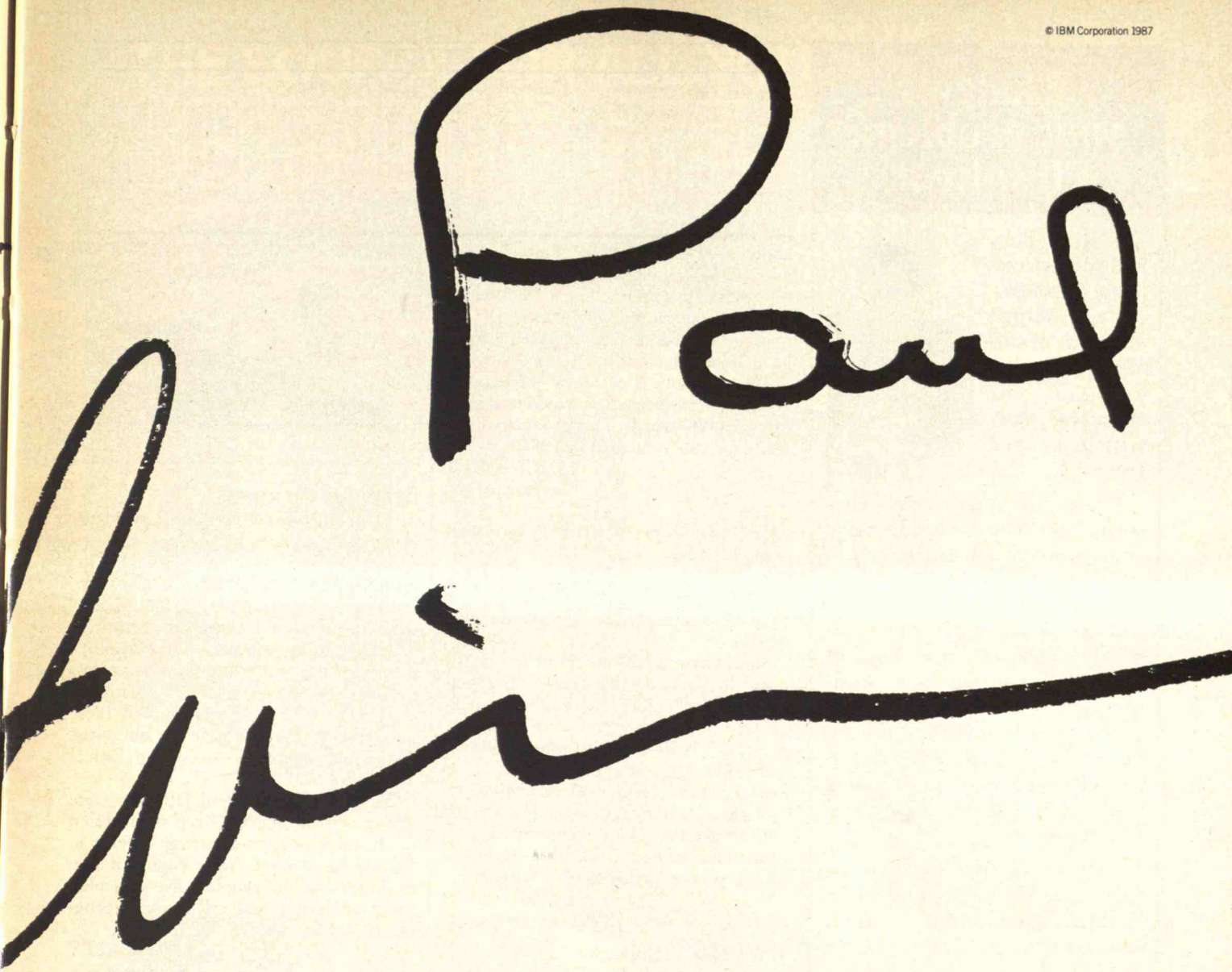
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CONTINUED FROM PAGE 5

about $7,000 to $9,000." But since August 1986, Dragon Systems, Inc., of Newton, Mass., has been selling a 1,000-word speech-recognition system for $1,195. A number of schools for disabled people have already bought it.

The company is currently working on an affordable system that would recognize up to 20,000 words. This product will be ready for sale sometime in 1987.

JANET BAKER
Newton, Mass.

Janet Baker is president of Dragon Systems, Inc.

I'd like to pass on another idea about how to make computers accessible to disabled people.

Since tongues are among the few highly controlled muscles that escape the effects of spinal-cord injury, quadraplegics might operate a computer by using a mouthpiece keyboard—one held either inside the teeth (like a boxer's mouthguard) or on the roof of the mouth (like a dental plate). The surface of the device would be covered with raised-bump keys similar to those on some calculators, and the most commonly used keys would cluster near the center.

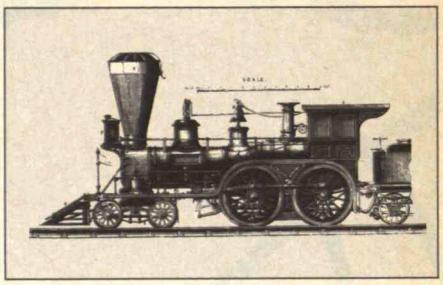
GEORGE KOCH
San Francisco, Calif.

The author responds:

I have long been aware of the important work that Dragon Systems has done on speech recognition. But to use the technology to which Ms. Baker is referring, an individual needs to have a computer with sufficient memory. This brings the total cost into the $7,000-to-$9,000 range.

Mr. Koch's invention would be quite a mouthful. I suggest that people with such intriguing ideas contact Lawrence Scadden, Electronic Industries Foundation, 1901 Pennsylvania Avenue N.W., Washington, D.C. 20006. Dr. Scadden manages a federal grant program designed to help bring special-needs products to market.

We're sorry we neglected to credit Helmut Wimmer, whose conception of a black hole appears on page 72 of the May/June 1987 issue.



DEFINING PROGRESS

In "Does Improved Technology Mean Progress?" (*January 1987, page 32*), Leo Marx commends Benjamin Franklin for his unwillingness to profit from his inventions and Thomas Jefferson for his idea that Europe should be the workshop for an agricultural America. Both earn applause for providing "limits to, as well as ends for, the progressive view of the future." The "heroic" leadership of these two thinkers is said to have lost out to the "industrial capitalists for whom Daniel Webster spoke."

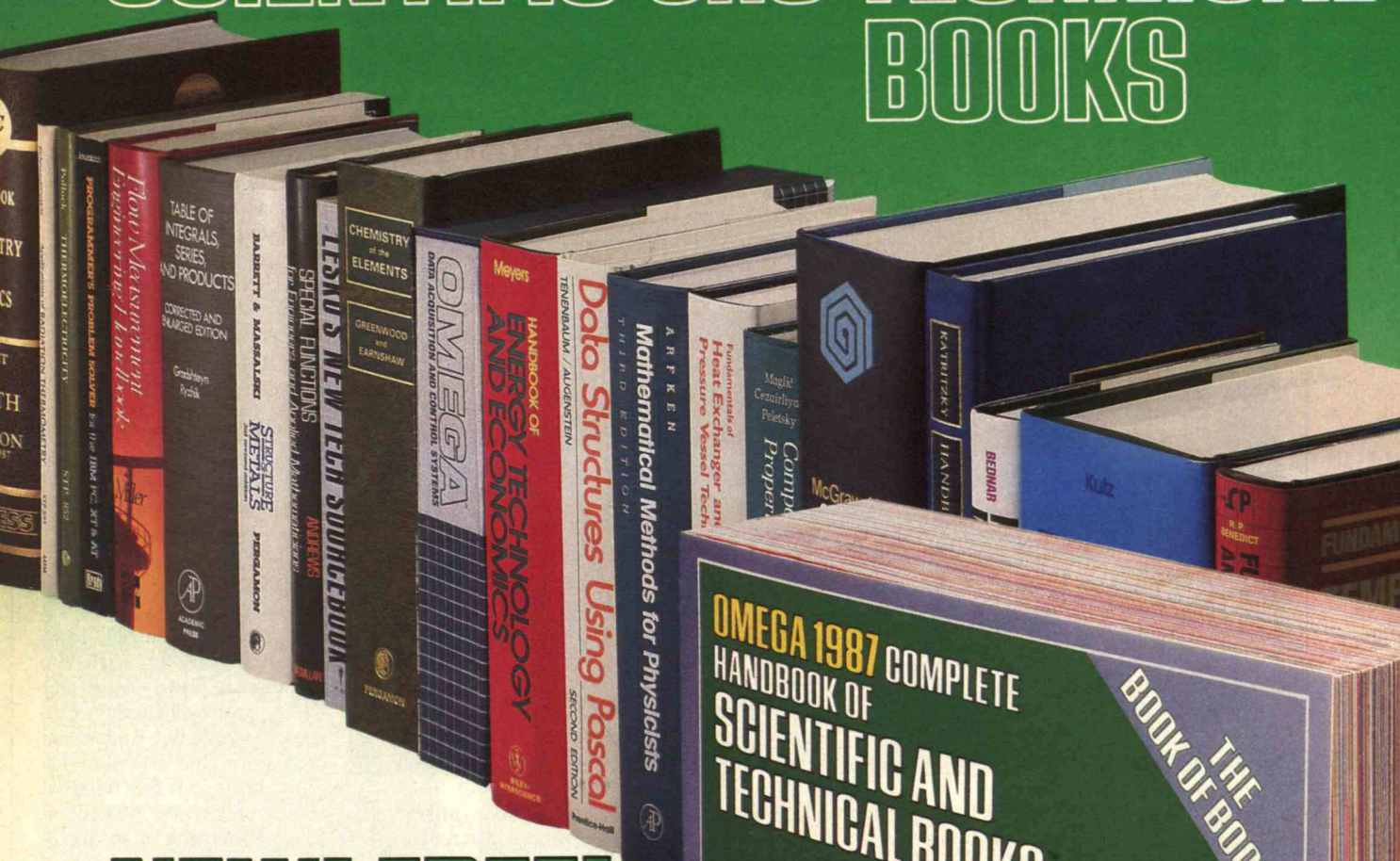
Yet what Franklin and Jefferson were saying was, in effect, "Keep them down on the farm and let technology develop in Europe. Limit what can be done and how to do it. Give the people a five-year plan for their destiny and call it social progress." Not for me. I'll take freedom.

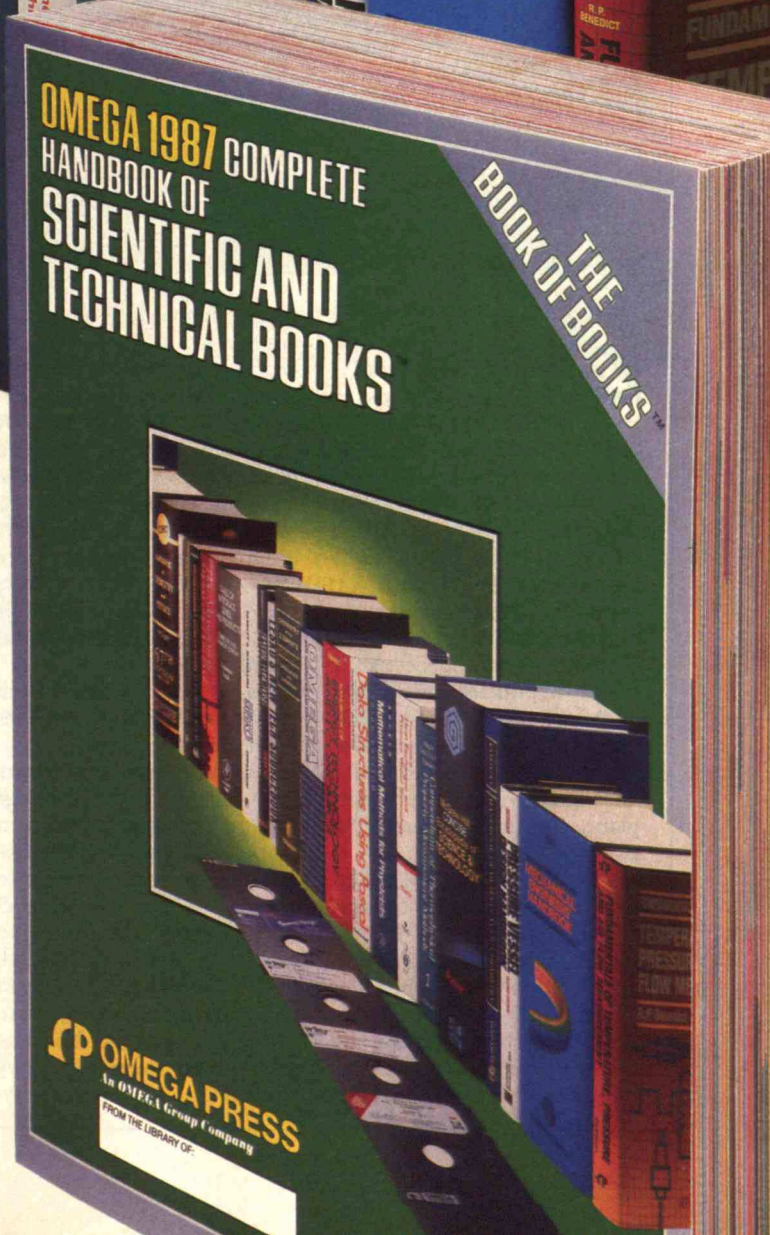
DELBERT OXLEY
Seattle, Wash.

The author responds:

Mr. Oxley is mistaken. Neither Franklin nor Jefferson would have been satisfied to "keep them down on the farm and let technology develop in Europe." They were both wholeheartedly committed to the advance of science and technology. But they also recognized the need to be clear about the larger social and political goals to which those advances are directed. Hence they would have disapproved of the technocratic faith in progress prevalent today, with its uncritical embrace of technological innovation for its own sake, and the rationale it provides for the indiscriminate application of science-based technologies to all spheres of life. That situation can in turn induce a kind of fatalism—the view that technology is the uncontrolled driving force of history—and it finally can breed a sense of political paralysis and social despair that threatens the very democratic freedom Mr. Oxley presumably would defend.

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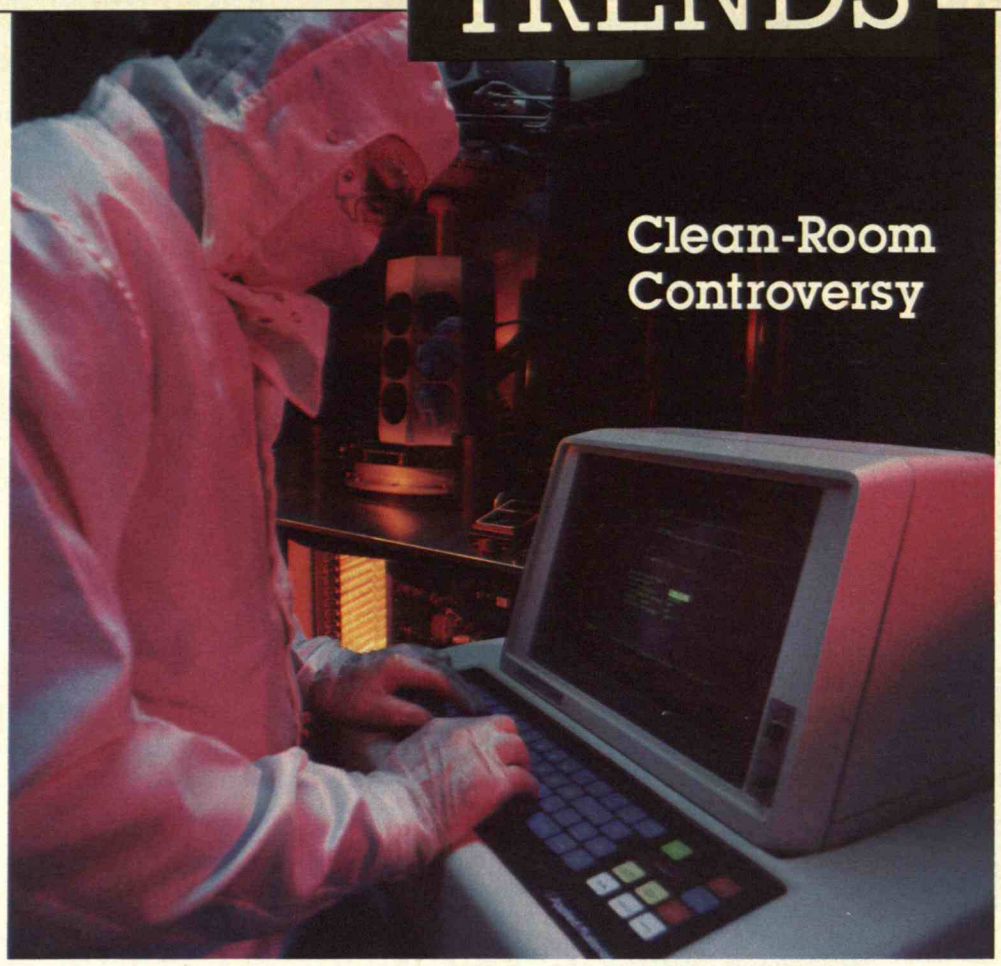
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Clean-Room Controversy

A study of semiconductor workers found miscarriage rates that are up to twice the national average.

A recent Digital Equipment Corporation (DEC) study addresses one of the most highly charged workplace health issues—toxic hazards that affect a worker's ability to have children. In January, DEC shared the results of the still-unpublished study with the press and the electronics industry. Semiconductor manufacturers responded with a variety of policies, but worker advocacy groups charge that these policies discriminate against women, fail to eliminate toxics from the workplace, and underestimate the risks men face.

The DEC study, conducted by the University of Massachusetts School of Public Health, is the most comprehensive look at the reproductive hazards associated with chip production to date. The research, which focuses on 744 workers, indicates a sharply higher rate of miscarriages among women at DEC's Hudson, Mass., production facility. In one department, 39 percent of pregnant women suffered miscarriages, nearly twice the national average. These employees worked in DEC's photolithography area, where they cleaned silicon wafers with acids and bathed chips in a light-sensitive material called photoresist.

To protect workers from the hazards and themselves from possible liability lawsuits, chip manufacturers have instituted a wide range of policies affecting pregnant workers. Digital strongly encouraged pregnant women to transfer out of chip production. The firm has also begun to offer free pregnancy tests. AT&T has assigned pregnant chip fabrication workers to other operations, but has guaranteed them that they will not lose pay or seniority.

David Frink, spokesman for Advanced Micro Devices (AMD) of Sunnyvale, Calif., a major chip manufacturer, believes there is no cause for alarm. "For years we have used extremely sophisticated and expensive systems to monitor the level of employee exposure to chemicals in the fabrication area." He says that exposure levels at AMD "are consistently well below" the levels set by the Occupational Safety and Health Administration (OSHA). However, OSHA currently regulates only four threats to reproductive health.

The Semiconductor Industry Association (SIA) contends that additional research should be done before any action is taken. SIA president Andrew Procassini has commented that the DEC study "did not provide an adequate foundation for mandating specific decisions regarding industry health practices."

More Investigations Planned

The study has aroused controversy among industry workers and other organizations as well. A coalition of 35 labor, health, women's, and environmental groups has challenged the industry response, concerned that companies have been removing workers from jobs instead of developing safe production methods. The coalition argues that "medical-removal policies" should be used only as temporary measures. And it thinks that workers should receive guarantees that their pay and status will not be diminished in their replacement jobs.

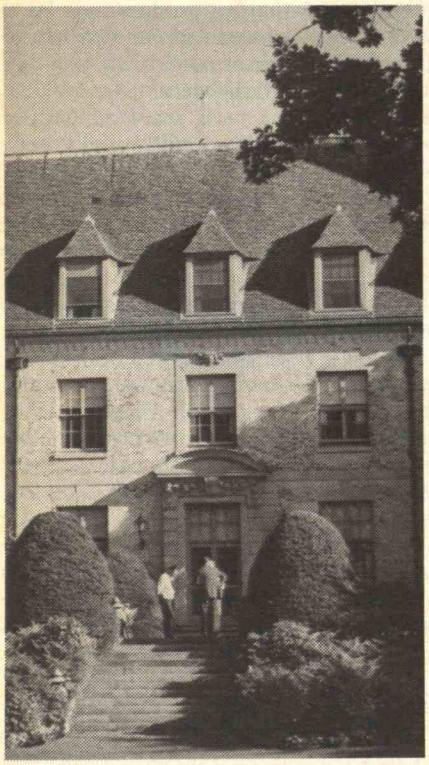
Coalition member Joan Bertin, a lawyer with the American Civil Liberties Union, says exclusionary policies violate Civil Rights Act provisions that prohibit discrimination on the basis of sex or pregnancy. Moreover, Ellen Silbergeld, a toxicologist with the Environmental Defense Fund in Washington, D.C., questions the DEC finding that male workers are not at risk. She says the test group was too limited to draw any significant conclusions about the dangers to them. A separate National Institute for Occupational Safety and Health report concludes that men exposed to glycol ethers, which are widely used in the semiconductor industry, have sharply reduced sperm counts. Only DEC and a few other companies offer special transfer consideration to male production workers who plan to be fathers.

The coalition suggests several directions industry R&D could take to develop alternatives to tranferring workers. One proposal asks manufacturers to limit the use of substances known or suspected to cause reproductive

PHOTO: MONSANTO CO.

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The MIT Program for Senior Executives





The modern executive faces a rapidly changing economic and business environment. Growing world trade and global markets, rapid development of new technologies, major changes in employer/employee and work relationships, shifting boundaries between government and private institutions—all are imposing significant new competitive challenges on managers.

The MIT Program for Senior Executives prepares managers to operate more effectively in this complex setting by:

Providing a deeper knowledge of trends in society and the world economy, and the forces behind them;

Developing familiarity with recent research of relevance to management and executive decision-making;

Improving problem-solving ability and strategic thinking;

Developing a more profound understanding of diverse values and lifestyles, and increasing the capacity to manage different types of individuals in varying organizational and cultural settings.

The courses that make up the Program are organized around four broad themes:

Policy Formulation and Implementation;

Human Resource Development;

The External Environment;

Managerial Decision-Making.

Assistance is also available to participants who wish to pursue topics of individual interest.

Participants represent a variety of private and public organizations, and widely differing functional specialities and educational backgrounds. All are experienced managers, usually in the 40 to 50 age range, with significant decision-making responsibilities.

The Program is held twice yearly, in the spring and in the fall. It consists of nine weeks of intensive study, including a short field trip to meet with high-level officials of the U.S. Government in Washington, D.C. Participants reside at MIT's Endicott House. The class size is limited to 50.

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damage. Some hazardous materials could be replaced with safer ones. And better engineering controls, including clean-room robots, could lessen exposure to other potentially harmful substances.

The coalition also calls for a comprehensive government study. In response, Labor Secretary William Brock has announced that OSHA will examine the possible health hazards of chemicals used in the semiconductor industry. According to OSHA representative Mikelson, the agency will "look at the semiconductor industry in general terms and do a full-fledged look at the Digital study."

If there is any consensus on the meaning of the DEC findings, it is that more research is necessary. The SIA will establish a panel to examine the issues the DEC study raises and to consider proposals for a larger epidemiological study of semiconductor workers. IBM, which rarely collaborates with other companies in the industry, will conduct its own research. And DEC has announced that it will sponsor a follow-up investigation.

Nevertheless, controversy remains high. "We don't believe there is a problem," thinks Steve Pedersen, SIA's director of environmental and OSHA affairs. "But we believe that we've got to answer the questions that come up." However, says Meta Mendel-Reye, director of the Santa Clara Center for Occupational Safety and Health, "It's a mistake to focus on a study because it makes it appear that nothing needs to be done right now." □

RAND WILSON coordinates Integrated Circuit, a national network of environmental, worker advocacy, and other organizations in high technology.

Rushing Drugs to Market

Whatever the final word on the therapeutic benefits of the anti-AIDS drug azidothymidine (AZT), its swift progress from laboratory to market heralds a change in the way some pharmaceuticals are tested and regulated in the United States.

Normally, a firm expects to test a drug for several years before submitting data to the U.S. Food and Drug Administration (FDA) for approval. The approval procedure itself takes, on average, thirty-six months. But responding to public pressure to act on AIDS, the FDA put AZT in a new top priority category; all future anti-AIDS drugs will be similarly classed. Reviewers at the agency waived final tests for AZT, approving it in an unprecedented five months.

Although few question the decision to approve AZT, the government's quick work has pricked a raw nerve in the drug industry, which has wanted the FDA to show as much zeal for other pharmaceuticals. The agency has responded by publishing new regulations intended to increase public access to experimental drugs. "We need to be more flexible, to provide experimental drugs to patients willing to take the risks," FDA representative Mark Shaffer remarked when the guidelines were first announced. He said FDA commissioner Frank E. Young had proposed that important products still under development be made available to patients near death.

Young had also suggested that firms be allowed to charge for these drugs. Previously, they have provided drugs for free during certain clinical tests. Members of the FDA panel that reviewed AZT say that one reason they approved it early was to permit Burroughs-Wellcome, the manufacturer, to charge for supplying it. AZT will cost about $8,000 per patient per year. The drug is costly to produce, and the company must recoup high R&D costs in a short time from a limited market.

Supporters say the new regulations should help patients with life-threatening illnesses. However, critics have argued that they are a step toward deregulating the drug industry and are driven by profit-hungry pharamaceutical companies. To satisfy some of these criticisms, the final regulations differed from Young's earlier proposals in one key aspect. They require that no product may be approved without sufficient evidence of its safety and effectiveness.

A Slow and Careful Process

The new regulations address delays inherent in the "drug pipeline"—the route from synthesis to approval. When a firm completes initial experiments on a new pharmaceutical product, it files an "investigational new drug" plan. FDA reviewers must approve the company's proposed clinical tests on humans. The FDA takes a second and much closer look after these often lengthy clinical tests are completed. If an FDA review panel is then satisfied that the pharmaceutical

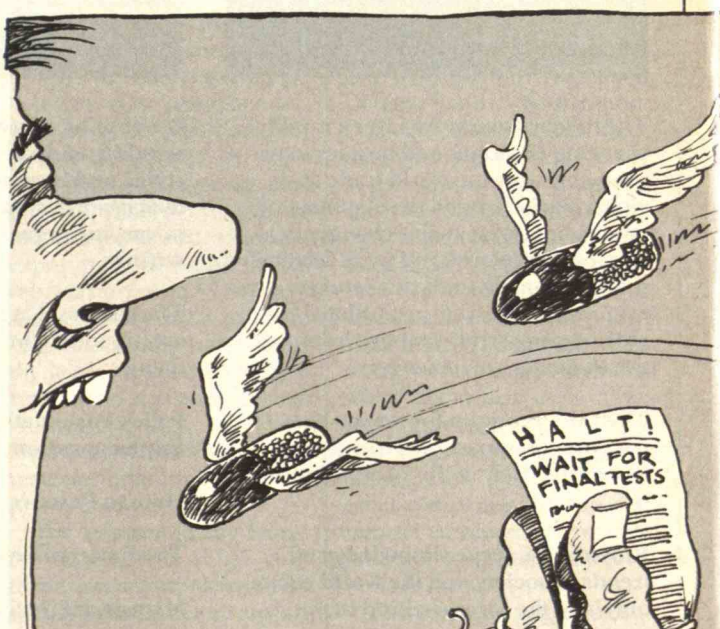


ILLUSTRATION: JON McINTOSH

is safe and effective, the agency approves it for public use.

That procedure has become increasingly complicated. In the last two decades pharmaceutical industry R&D has shifted its focus from acute diseases to chronic diseases. Treatments for these ailments are more difficult to develop and manufacture, requiring additional research and considerably more paperwork. For example, at about the time AZT was approved, The Upjohn Co. submitted a mass of data on Rogaine, a new hair-growth drug, to the FDA. Jim Shamp, an Upjohn representative, says the paperwork "filled a plane. Literally."

To equitably cope with the work load, the FDA prioritizes drugs. Those that are unique, promising, and designed to combat a life-threatening disease are reviewed first. Companies rarely disagree with the classification assigned to their drugs, but that doesn't mean they're happy with the time it takes for approval. In 1986 the FDA approved one high-priority antileprosy pharmaceutical it had received in mid-1984. But that drug, as well as all 19 others approved in 1986, had been in the pipeline for at least a decade.

One consequence of delays is that the standard 17-year patent life is usually more than half over before a product can reach its market. Companies try to recoup their investment—currently this amounts to about $80 million to $100 million—before the patent expires. The consumer picks up the tab.

Delays also influence research. "In general, drug companies may consider the likely FDA classification when deciding whether or not to enthusiastically back research on a drug," says Tania Assaykeen, president of Astra Clinical Research Associates, a division of the Swedish firm AB Astra. The lower the classification, the greater the risk that a drug will not pay for itself before the patent runs out.

Delays most affect patients awaiting the drugs, and they push hard for making experimental drugs available. Even after AZT was approved, Larry Kramer, a founder of Gay Men's Health Crisis, the largest self-help AIDS organization in the country, charged that "there is no question on the part of anyone fighting AIDS that the FDA constitutes the single most incomprehensible bottleneck in American bureaucratic history—one that is actually prolonging this roll call of death."

However, FDA representative Shaffer maintains that "the delay isn't all the FDA's fault. If a company doesn't supply us with adequate or complete data, we can't approve the drug." And Faye Peterson, also from the FDA, advocates "more cooperation between government and industry" to avoid "wasting time coming up with unnecessary data."

In this case, too, AZT may be a precedent. Representatives from Burroughs-Wellcome and the FDA met in 1985, two months before the company submitted its plan for testing the drug. The FDA review panel had enough data to make their recommendation just 16 months after patients first received AZT in a clinical trial and after only 11 months of such testing on humans. □

THOMAS KIELY is a Boston-based free-lance writer specializing in medical and human-service issues.

Engineering schools are trying to put principles of efficient manufacturing back into the educational mainstream.



"Competitiveness" Fever

Rarely does a president of the United States place civilian technology at the top of the nation's agenda. It is hardly surprising, then, that President Reagan's "competitiveness initiative" is a magnet for rhetoric and action in the engineering community. Proposed in his 1987 State of the Union address, the initiative seeks ways to improve the ability of U.S. products to compete in world markets.

Toward the same goal, engineering schools are busily developing and promoting proposals to put design and the principles of efficient manufacturing back in the educational mainstream. The hypothesis is that new applications of novel materials and exotic phenomena have held the spotlight in engineering education since World War II. In the process, educators lost track of the need to show students how to design relatively conventional products that are efficient, long-lasting, and inexpensive.

Proposals to turn the situation around were brought to the annual technology policy conference of the Institute of Electrical and Electronics Engineers (IEEE) early this year in Washington. A skeptic might conclude that "competitiveness" is only today's slogan for a wide range of changes many educators have promoted since World War II. But an optimist would note a strong resolve to return to prominence some of the basic engineering concepts upon which the nation's economic strength depended in the first half of the twentieth century.

Karl S. Pister, dean of engineering at the University of California at Berkeley, advocated a fifth year for all engineering students so that they could learn multi-disciplinary engineering skills. A five-year curriculum could include courses on management principles and even the social and cultural issues that help determine how buyers would receive new products.

Several people at the IEEE conference were uncomfortable with the five-year idea. Jerrier Haddad, retired vice president of IBM, said it would be expensive and would make engineering less attractive to many students. Instead, he thinks the four-year program should include

PHOTO: IVAN MASSAR/BLACK STAR

more about the "business practice necessary to do a good engineering job [and] the interrelationships between technical decisions and business decisions."

Darrell L. Vines of Texas Tech University advocated a national technology policy of increased support for graduate study for the best engineering students in order to develop their talents as designers. And M.I.T. president Paul E. Gray was among the advocates of a return to basics: "We must teach engineering students and their employers to value people who are expert in how things are made and how well things are made."

Centers of Excellence

Even before the IEEE conference, the National Science Foundation (NSF) had turned its "centers of excellence" program toward the goal of competitiveness. This system of block grants aims to create research establishments for key technological problems. Reagan's competitiveness initiative includes doubling NSF's budget in the next five years, mostly to step up that program. Already a number of universities are committed to multidisciplinary research centers linked to industry in fields such as supercomputers, biotechnology, ceramics, and robotics.

But George Washington University's Harold Liebowitz is uneasy with the emphasis on competitiveness. It would be "a catastrophe," he says, "if all engineering schools focus on a single goal." And many in the scientific community have been highly critical of the centers of excellence, charging they divert NSF from basic science.

Edward Ernst of the University of Illinois has urged engineering schools to change slowly if at all in response to the thrust toward competitiveness. He observes that since competition may require technology no one knows about yet, "colleges should . . . be less concerned about solving today's problems than understanding and finding solutions for the problems of the next decade."

W. Dale Compton, senior fellow of the National Academy of Sciences, agrees. In our haste to focus new attention on manufacturing, we run two risks, he points out. First, we may warp a system of technological education that is "the envy of every industrial nation." Further, if we permit the government to become too involved, we may confer on it an improper responsibility: directing industry's choice and use of technology.

Compton thinks a better response would be to let universities cultivate their students' understanding of the full range of industrial problems—innovation, research and development, manufacturing, marketing, financial management.

One means of doing this would be to attract faculty with more experience in industry. Another approach would be for universities and industry to collaborate in continuing education programs. "If higher education doesn't step forward," warns Compton, "the private sector will seize this opportunity and take from the universities a uniquely effective way of building bridges to industrial needs." □

JOHN MATTILL is editor-in-chief of Technology Review.

Replanting Mt. St. Helens

Once a wasteland, the 150,000-acre area decimated by the 1980 eruption of Mount St. Helens is now lush and green. Thanks to the United States Department of Agriculture (USDA) Forest Service, the Washington State Department of Natural Resources, and Weyerhaeuser Corp., 42 percent of the original blast zone has been replanted. Some of the young evergreens are now 10 feet tall.

Jerry Gutzwiler, north district forester for Weyerhaeuser, remembers, "The first time I flew over in a helicopter, everything was gray. There were dead animals and broken logging equipment scattered everywhere. Fires burned. I thought, 'This is what hell must be like.' "

When Mount St. Helens erupted, the north portion of it blasted into the air, enshrouding 234 square miles with a 300° F cloud of ash that instantly killed forest and animal life. Rivers of mud and debris cascaded down the side of the volcano, snapping 400-year-old trees. The ash was 18 inches deep in places, with a consistency of "dry beach sand," says Gutzwiler.

In the aftermath, state and local officials and Weyerhaeuser—which owned 68,000 acres of land surrounding Mount St. Helens—faced the overwhelming problem of salvaging what had once been highly productive forest. While it was known that forests can regenerate naturally over hundreds of years, no one had attempted to resurrect one on volcanic ash before.

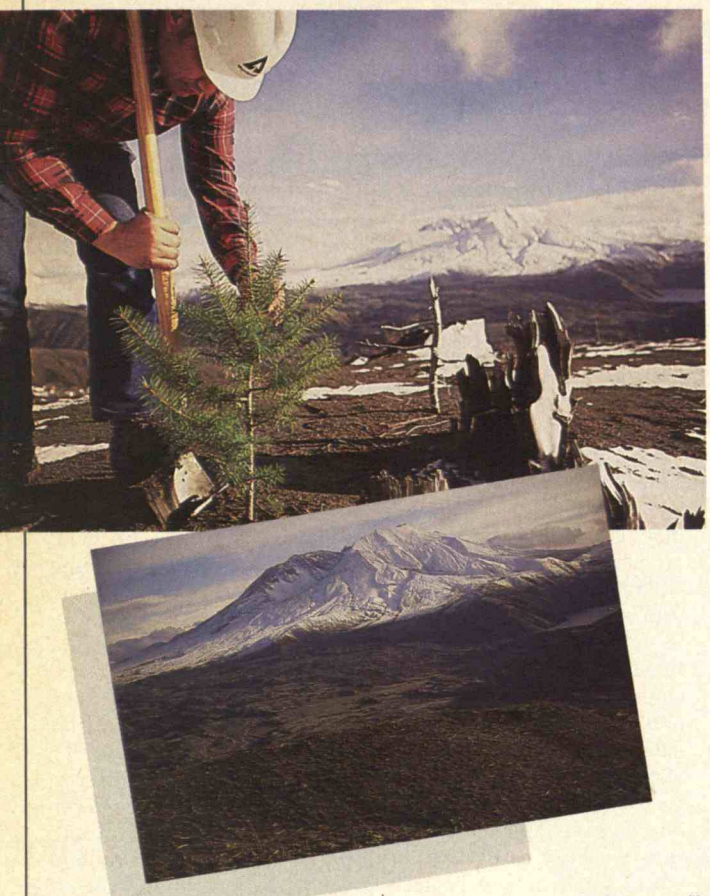
Jack Winjum, then Weyerhaeuser's senior forest scientist, says the first clues that replanting would be feasible came only 10 days after the eruption as bracken ferns and fireweed shoots began to poke out of the ash. With their roots protected deep in the underlying soil, they had survived burial. A 1915 study of natural vegetation in volcanic ash on Alaska's Kodiak Island also helped convince Weyerhaeuser to invest in the project.

First the debris had to be cleared away. For days, foresters flew over the site in helicopters, dumping fuel to burn away impenetrable, fallen forest. Bulldozers with special V-shaped blades plowed aside ash to expose rich mineral earth.

But the biggest problem, according to Winjum, was finding enough evergreen seedlings that late in the planting season. The two nearby Weyerhaeuser nurseries could only furnish enough to cover 8,000 to 12,000 acres—far short of the company's 43,000-acre goal—and it takes as long as three years to grow hardy evergreen seedlings. So Weyerhaeuser staggered its planting over five years. From 1981 to 1985 foresters hand-planted 17.5 million Douglas fir and Noble fir seedlings. Hungry elk and birds have devoured many of these, but today trees 10 feet tall are thriving.

The USDA Forest Service has replanted 14,000 acres of land on the east and northeast side of the volcano. Government forester Eugene Sloniker says the ash there is as coarse as popcorn. It is two feet thick in some areas and cannot be scraped away, so foresters have planted seedlings right on top of it. The coarse ash

Trees now thrive on much of the wasteland created by the 1980 eruption of Mount St. Helens.



allows seedling roots to push down to the underlying soil.

On the southwest side of the volcano, the Washington State Department of Natural Resources has started a pilot project that imitates—and may even stimulate—natural growth.

Kenelm Russell, a forest pathologist for the state, describes the southwest area of debris flow as a strip of concrete-like soil 14 miles long, two-thirds of a mile wide, and up to 250 feet deep. "We went back there in July, and after a whole day of searching for life, we found a little Douglas fir that had been buried under a snow drift," he says. Protected under the snow, the young fir had weathered the eruption and seemed to be surviving in the rock-hard soil.

This encouraged Russell and his colleagues to plant a 40-acre test plot smack in the middle of the area. Unlike Weyerhaeuser and the USDA Forest Service, Russell planted a variety of seedlings to mimic the mixture found naturally. Particularly successful were red alders and Sitka alders, whose roots contain bacteria that draw nitrogen from the air—a great advantage for trees growing in nitrogen-poor volcanic soil.

Today, the test communities are thriving, and Russell hopes vegetation will spread naturally from them. He calls the technique "giving nature a nudge." □

SHARON KAVESKI is a freelance writer living in the Boston area.

Voting on the Environment

Impatient with the compromises and delays that characterize the conventional legislative process, some environmentalists are getting laws passed by popular vote. Their successes at the ballot box indicate that the public is often more receptive to their prescriptions than are elected officials.

California environmentalists are basking in the glow of last fall's Proposition 65, the "safe drinking water and toxics enforcement" initiative. Approved by 63 percent of voters, the new law protects water supplies by regulating the disposal of approximately 200 chemicals known to cause cancer and birth defects. In addition, businesses that expose workers and communities to these chemicals are required to inform them of it.

On the East Coast, voters approved bond issues last November to pay for toxic-waste cleanup in New York and New Jersey, and a similar initiative from the Massachusetts Public Interest Group won 73 percent approval—passing by a wider margin than any voter-initiated ballot measure in the state's history. The Massachusetts vote also illustrates that the issues are not simple: some environmental organizations, including the Sierra Club, opposed the measure.

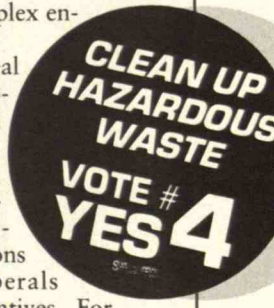
Nor do voters approve all actions proposed by environmental organizations. Citizens in Maine have rejected a proposal to shut down the state's only nuclear plant, and Oregon voters defeated a 1986 move to close the Trojan nuclear plant. However, in the wake of the Soviet nuclear disaster at Chernobyl, ballot initiatives against nuclear power have gained popularity. In 1987, citizens in both states will again be voting to close nuclear plants.

Oregon voters will also reconsider another matter. In 1986, they defeated an initiative that would have forced Teledyne Corp. to remove low-level radioactive sludge from a holding pond at the company's defunct zirconium-refining plant on the Columbia River. This year, they will have a chance to reverse their decision.

"Bottle bills" have been more successful. Since 1976, voters in Maine, Massachusetts, and Michigan have passed such legislation, which puts a nickel or dime deposit on beer and soft-drink containers to encourage recycling and reduce litter. In the nation's capital, a bottle bill initiative is slated for November 1987. Environmental groups hope a victory there will be a key to a national bottle bill.

Controlling Growth

Perhaps the most controversial and complex environmental initiatives deal with development. Local measures to control land use often ignore traditional divisions between liberals and conservatives. For example, restrictions meant to preserve the environment often protect the privileges of a few citizens. Also, keeping out unwarranted construction can raise the cost of ex-



PHOTOS: WEYERHAEUSER CO.; BUTTON: COMMON CAUSE/MASSACHUSETTS

Environmentalists are turning to the ballot box. In Massachusetts, a toxic-cleanup proposal passed by an overwhelming margin.

isting housing.

In 1972 trend-setting Californians came out in favor of an initiative limiting urban and industrial development along the coast. Since 1976, California cities and counties have voted on at least 75 measures to slow or channel urban expansion, approving two-thirds of them. The public will face more opportunities to curb growth, including one planned for densely-populated Orange County in June 1988.

Two other major environmental initiatives are in the works for California for 1988. The Planning and Conservation League is sponsoring a proposal that would issue $500 million worth of bonds, enabling the state to buy land for parks and wildlife preserves. And a variety of public-health groups—including the California affiliates of the American Lung Association, the American Cancer Society, and the American Medical Association—are pushing for a 25-cent tax on each pack of cigarettes. The proceeds would fund anti-smoking education, cancer research, and medical benefits.



Even in Europe, environmentalists are turning to initiatives and referendums, although the legal obstacles are greater there. Only the Swiss and, to a lesser extent, the Italians have explicit rights to these procedures. Italian environmentalists, including the Green Party, have collected a million signatures on a petition to force a national vote on repeal of the country's exceptionally permissive hunting law.

Activists in Holland and West Germany have launched campaigns to get initiative and referendum rights. For example, in December 1985 West Germany's environmentalist Green Party issued a "manifesto for direct democracy" that calls for a constitutional provision for a national initiative and referendum procedure. And even without such rights, another West German group is pressing for a vote to shut down the nation's nuclear plants. □

DAVID D. SCHMIDT is executive director of the Initiative Resource Center, a clearinghouse for information on initiatives and referendums.

Biotech in Court

The top biotech companies are fighting over whether a firm can have sole rights to market engineered proteins that closely resemble existing ones. For example, synthetic human growth hormones, used to treat dwarfism and burns, are extremely similar to the hard-to-acquire natural variety. Moreover, competing manufacturers have produced human growth hormones that are almost identical.

Patent law has been slow to deal with the issues involved. In 1980, the Supreme Court ruled that a microorganism could be patented. And not until this April did the U.S. Patent Office extend this protection to higher forms of life created by altering a natural one, including plants and animals. The question of whether patent law protects minor variants is still unanswered.

Patent issues are central to the biotechnology industry. To date, only a few lucrative proteins have been developed, and many companies are competing to make them. In addition to human growth hormones, scientists have come up with interleukin 2, which fights cancer, and tissue plasminogen activators, which help dissolve blood clots and treat cardiovascular disorders. A few more products exist, but the list is decidedly brief.

Under established law, any product, process, or use may be patented if it is novel, has utility, and the inventor can teach others how to produce it. But the invention must also be "non-obvious." For example, a drug that totally differs from anything that already exists qualifies as non-obvious.

"That is the real bugaboo," says William H. Duffey, general patent counsel at Monsanto, based in St. Louis, Mo., a major biotech company. A drug that is a variation on a theme played by Mother Nature—or by a competitor—may not qualify. Is a bioengineered protein non-obvious if it differs from a natural protein by a hundred of the amino acids that make it up? How about if ten differ? Or even one?

In fact, some disputed proteins differ by a single amino acid. In a dispute that could set a precedent, Genentech and Eli Lilly, two industry leaders, have each produced a synthetic human growth hormone. Genentech's Protropin was introduced in 1985 and the company sold $41 million worth of the drug in 1986. It has 192 amino acids. Eli Lilly's Humatrope, approved by the U.S Food and Drug Administration (FDA) early in 1987, has 191. Otherwise, the products are essentially identical.

Orphan Drugs

Genentech was irked when the FDA gave Lilly "orphan drug status" for Humatrope. Congress established this designation in 1983 to promote commercial interest in products whose potential medical value and development costs are high but whose profits may not be. Orphan drug status is especially important when patent rights are unclear, since it gives a manufacturer desirable tax credits and seven years of exclusive marketing rights.

Continued on p. 18

PHOTO: WENDY SIMPSON

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Genentech's Protropin is one of several drugs involved in disputes over the marketing rights to engineered proteins.

Genentech was concerned because Protropin had already received orphan drug status. Now the company is suing the FDA over its decision to give the Lilly product the same status on the basis of the one-amino-acid difference.

Genentech claims that the regulatory agency has violated the company's property rights. Underlying the challenge is concern that the FDA has yet to establish clear rules for granting orphan status.

To complicate the matter, Serono Labs proposes to market Saizen, its own 191-amino-acid growth hormone. It produces Saizen by bioengineering mammalian cells—rather than the bacteria that Genentech and Lilly use. Serono argues that this novel production technique entitles Saizen to a patent.

Human growth hormone is not the only disputed product. Amgen and Cetus are in court over interleukin 2. Their products, too, differ by one amino acid. And in Great Britain Genentech is battling Burroughs-Wellcome over tissue plasminogen activator.

Monsanto's Duffey thinks that the dilemma of what constitutes novelty will be resolved when advanced techniques are perfected to produce proteins for a specific application almost from scratch. "The next generation of proteins will have clearly distinct structures and modes of action," Duffey says.

For the short term, says Gerry J. Elman, editor of *Biotechnology Law Reports*, a special federal court of appeals created in 1984 to hear patent cases should help resolve current disputes. Before Congress established this body, courts with little scientific expertise heard patent appeals. "A new, centralized court devoted to issues of intellectual property should make the analysis of patents more rational and increase the protection afforded U.S. technology," Elman points out.

Meanwhile, Congress is moving to improve the Orphan Drug Act, which is up for renewal in 1988. One goal is to clarify the grounds for orphan drug status, addressing the question of slight differences between competing products. The law might also be reformed to specifically exclude situations in which economic incentive to develop a pharmaceutical already exists and companies need no legislative encouragement. □

ANNE S. MOFFAT is a freelance writer specializing in science, medicine, and technology.

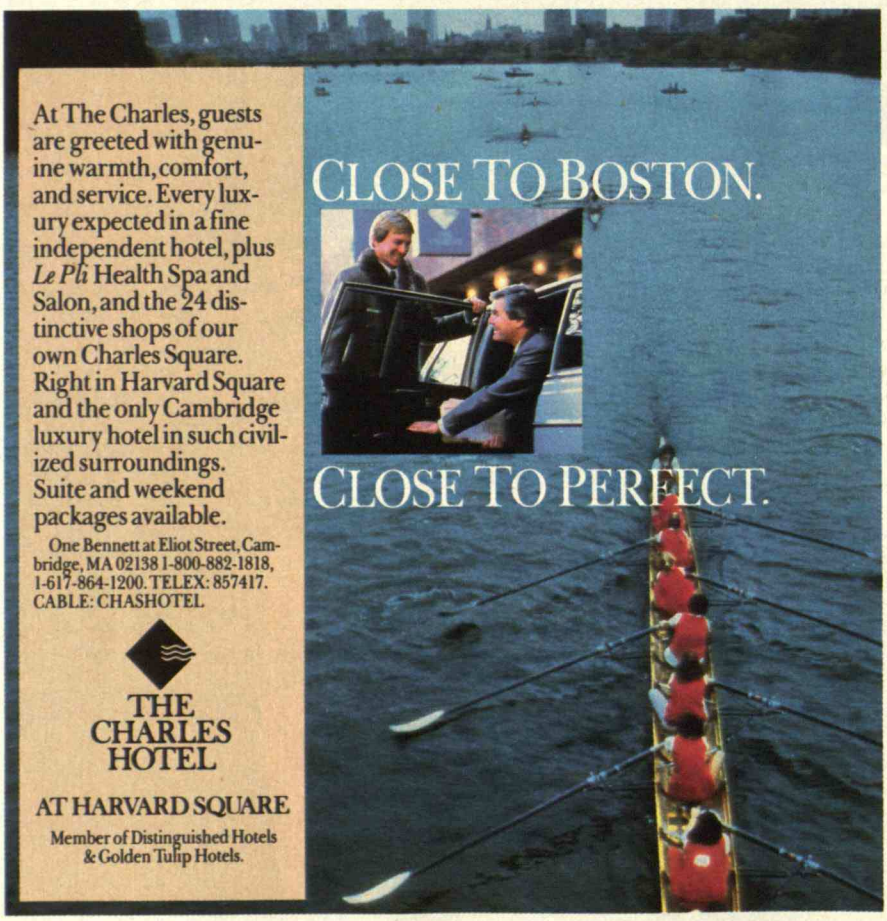


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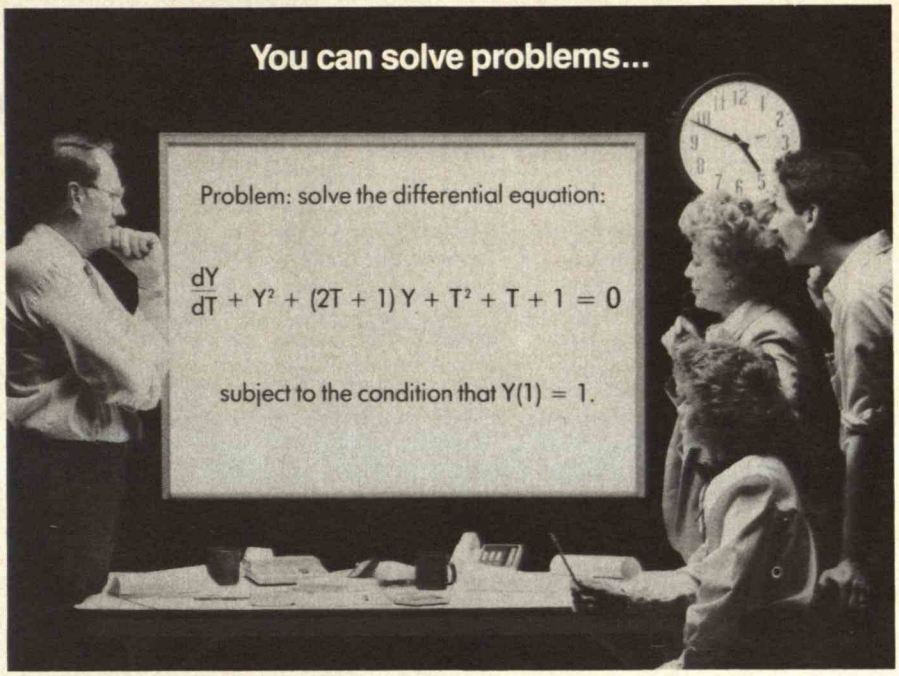
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(C1) DEPENDS(Y,T)$
(C2) DIFF(Y,T)+Y^2+(2*T+1)*Y+T^2+T+1;
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$$(D2) \quad \frac{dY}{dT} + Y^2 + (2T + 1)Y + T^2 + T + 1$$

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(C3) SOLN:ODE(D2,Y,T);
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$$(D3) \quad Y = -\frac{\%C\,T\,\%E^T - T - 1}{\%C\,\%E^T - 1}$$

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(C5) SPECIFIC.SOLN:SUBST(D4,SOLN);
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$$(D5) \quad Y = -\frac{0.5518192\,T\,\%E^T - T - 1}{0.5518192\,\%E^T - 1}$$

and Numerically.

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(C6) FORTRAN(D5)$
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     1    /(0.5518192*EXP(T)-1)
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MINI-TRENDS

PYRAMID MAGIC

New evidence suggests that Egypt's pyramids may have been constructed of stone blocks made at the building site. This contradicts the theory that thousands of people hauled immense stones from up to 50 miles away.

The information comes from re-deciphering a hieroglyphic text called the Famine Stele, says Joseph Davidovits of the Institute for Applied Archaeological Sciences at Barry University in Florida. The text states that Egyptian gods told Pharaoh Zoser, who directed the construction of the first pyramid in 2750 B.C., to make synthetic stone. According to Davidovits, 650 of the 2,600 hieroglyphics on the stele deal with stone making.

"It described [chief architect] Imhotep's revelations and Zoser's dream, wherein Khnum, a god worshipped by pyramid builders, revealed technology for building temples and pyramids," he says. "Pharaoh Zoser was given a list of 29 minerals and ores which have been processed with natural aggregates such as limestone to build the temples of the gods and the pyramid of the king." The mixture might have been poured into wooden forms, which would explain why the stones fit so perfectly.



Davidovits thinks the Soviets should have covered the Chernobyl site with the long-lasting stone found in the pyramids. Instead, they used portland cement, which has a life span of perhaps 150 years.

SHINE ON

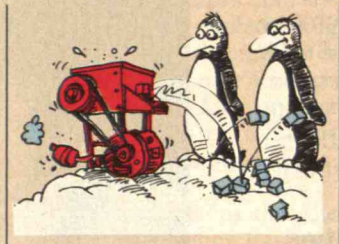
University of Chicago chemists have developed the first known stable form of the "chemiluminescent" compounds that are responsible for the light emitted by fireflies, predator fish in the deep sea, and some microorganisms. Previously, the risk of an explosion meant that scientists studying such compounds could deal only with very small samples, says researcher Nien-Chu Wang. "We can make jars of these new compounds and study them at our leisure. And we can know we will have a laboratory to come back to."

Yang is working to produce related compounds that emit light more efficiently. These compounds could be the basis for new types of lasers if the light they emit could be made "coherent"—that is, if the electromagnetic waves in it could be coordinated with each other.

ICE TO THE ARCTIC

Making ice in the Arctic seems like carrying coal to Newcastle, but Amoco engineers have created an artificial ice island in Harrison Bay off Alaska's north shore. The so-called Mars spray-ice island served for several months as a platform for drilling an offshore well. It accommodated the drilling rig and a camp for 48 people.

Oil companies usually use artificial gravel islands for drilling offshore Arctic platforms. Amoco researchers say



that "the cost of an ice island at this site was less than one-third the estimated cost of a gravel island," saving the company about $25 million. They built the island using four pumps, each of which was capable of spraying 5,000 gallons per minute. The island construction, which took 46 days, occurred on water that was already covered with ice. The pumps sprayed seawater, which froze and built up, causing the island to gradually come to rest on the sea floor.

SICK BUILDINGS

Tight buildings save energy, but they also cause the "sick-building syndrome" for many people inside them. The symptoms include headaches, nausea, irritated eyes, unexplained allergies, and more. The cause is pollution—ozone from copy machines, carbon monoxide from passing traffic, radon from the earth. A National Institute for Occupational Safety and Health study of 350 sick-building complaints showed that inadequate ventilation caused half.

During the energy crisis, the American Society of Heating, Refrigeration and Air Conditioning Engineers, which sets standards that many municipalities follow, had required less fresh air in buildings. This year, in response to growing concern about indoor pollution, it finally tripled the requirement.

Charles Billings, an environmental health scientist at Johns Hopkins, is a consultant in many sick-building cases. He often proposes more fresh air as a starting point. To a manager of a sick high rise in Washington, D.C., he made a simple suggestion: open a window. "The problem," says Billings, "is it's a trade-off between energy and the environment."

BIRD DIALECTS

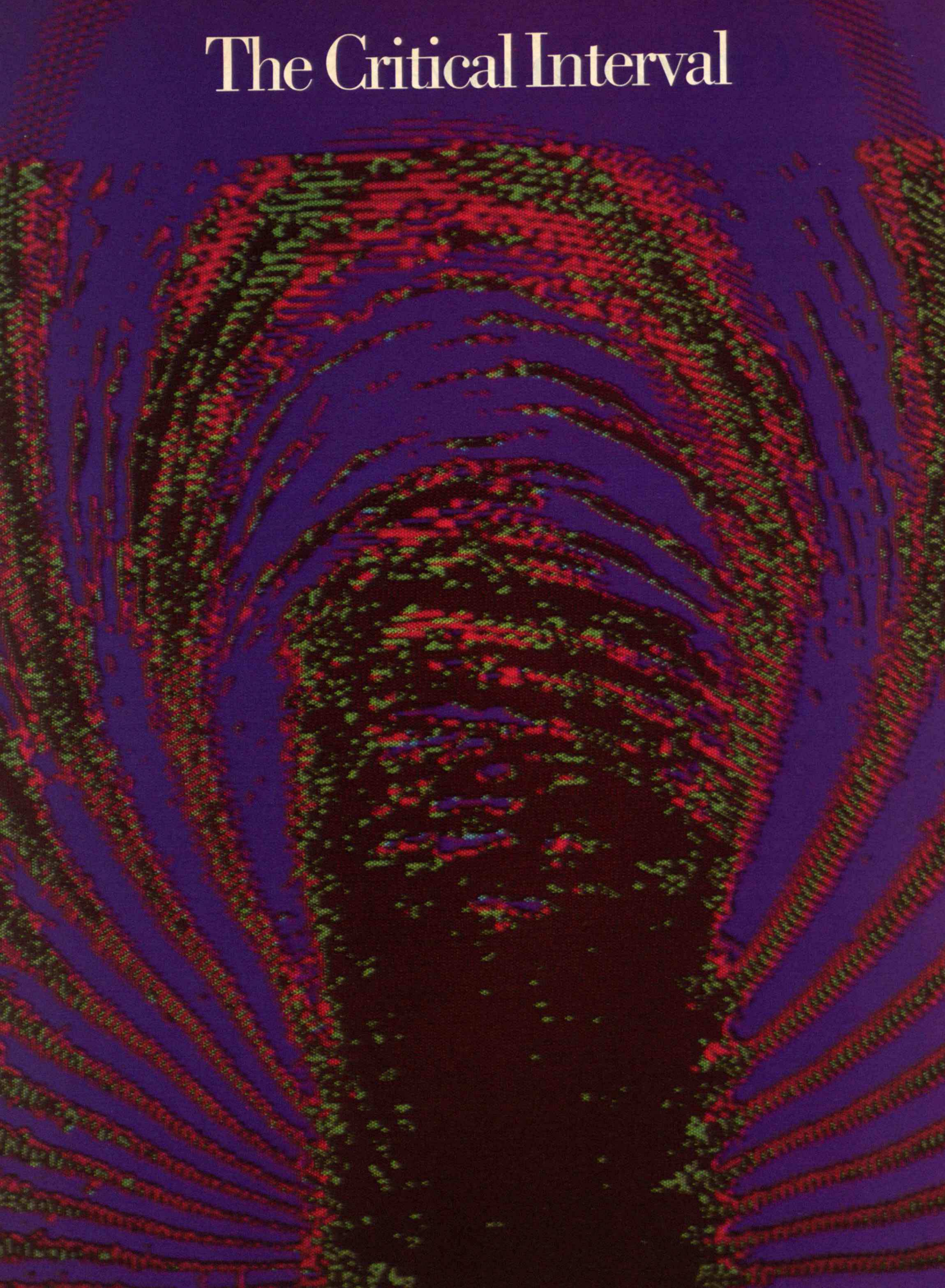
Why do Bostonians say "pahk the cah" while Southerners intone "ya'll"? The brown-headed cowbird may help supply an answer. Stephen Rothstein of the University of California at Santa Barbara and Robert Fleischer of the University of Hawaii analyzed the cowbird's flight whistles, in which clear dialects are evident, and they have proposed a new theory for songbird linguistics.

Through extensive observations in the Sierra Nevada mountains, the scientists have determined that male cowbirds do not discriminate among potential mates on the basis of their dialect. Females, however, respond more frequently to males using the local whistle. Since newcomers take considerable time to learn the local dialect, the female knows that a male singing a familiar tune can defend local territory. This indicates his fitness as a mate.

The researchers say it is premature to apply their discovery to other birds, let alone to other animals. But if confirmed by future studies, their idea may help illuminate why human dialects persist. One theory of dialects says they are an evolutionary holdover that actually hinders adaptability by constraining people's social and occupational acceptability.

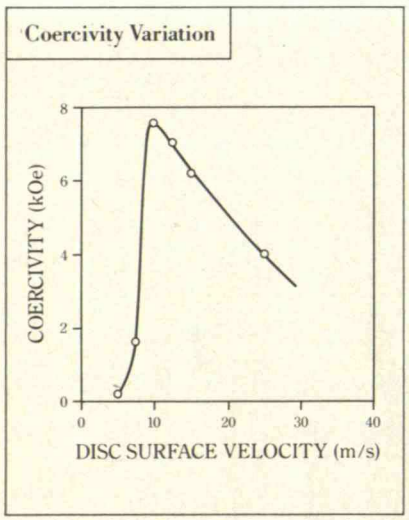
ILLUSTRATIONS: JON McINTOSH

The Critical Interval



The Critical Interval

There has long been a need in the industrial world for low-cost, high-performance permanent magnets. Discoveries at the General Motors Research Laboratories have led the way toward meeting this challenge by the application of new preparation techniques to new rare-earth magnetic materials.



Coercivity of $Pr_{0.4}Fe_{0.6}$ plotted as a function of disc surface velocity.



Color-enhanced transmission electron micrograph of melt-spun $Nd_{0.4}Fe_{0.6}$ having 7.5 kOe coercivity.

TWO properties characterize desirable permanent magnets: large coercivity (magnetic hardness or resistance to demagnetization) and high remanence (magnetic strength). Higher-performance magnets are required to reduce further the size and weight of a wide variety of electrical devices, including d.c. motors. Such magnets are available, but the cost of the materials necessary to produce them severely limits their use. The research challenge is to select, synthesize, and magnetically harden economically attractive materials of comparable quality.

Prominent among alternative materials candidates are alloys composed of iron and the abundant light rare earths (lanthanum, cerium, praseodymium, neodymium). Investigations conducted by Drs. John Croat and Jan Herbst at the General Motors Research Laboratories have led to the discovery of a method for magnetically hardening these alloys. By means of a rapid-quench technique, the researchers have achieved coercivities in Pr-Fe and Nd-Fe that are the largest ever reported for any rare earth-iron material.

Drs. Croat and Herbst selected praseodymium-iron and neodymium-iron based upon fundamental considerations which indicate that these alloys would exhibit properties conducive to permanent magnet development. These properties include ferro-magnetic alignment of the rare earth and iron magnetic moments, which would foster high remanence, and significant magnetic anisotropy, a crucial prerequisite for large coercivity.

That these materials do not form suitable crystalline compounds, an essential requirement for magnetic hardening by traditional methods, presents a major obstacle. Drs. Croat and Herbst hypothesized that a metastable phase having the necessary properties could be formed by cooling a molten alloy at a sufficiently rapid rate. They tested this idea by means of the melt-spinning technique, in which a molten alloy is directed onto a cold, rotating disc. The cooling rate, which can be varied by changing the surface velocity of the disc,

can easily approach 100,000°C per second. The alloy emerges in the form of a ribbon.

THE researchers found that variations of the cooling rate can dramatically affect the magnetic properties of the solidified alloys. In particular, appreciable coercivity is achieved within a narrow interval of quench rate.

Equally remarkable, synthesis and magnetic hardening, two steps in conventional processing, can be achieved simultaneously.

"X-ray analysis and electron microscopy of the high coercivity alloys reveal an unexpected mixed microstructure," states Dr. Croat. "We observe elongated amorphous regions interspersed with a crystalline rare earth-iron compound."

Understanding the relationship between the coercivity and the microstructure is essential. The two scientists are now studying the extent to which the coercivity is controlled by the shape and composition of the amorphous and crystalline structures.

"The development of significant coercivity is an important and encouraging step," says Dr. Herbst, "but practical application of these materials requires improvement of the remanence. Greater knowledge of the physics governing both properties is the key to meeting the commercial need for permanent magnets."

TECHNOLOGY UPDATE: 1987

Subsequent to the research reported above, Drs. Croat and Herbst added boron to neodymium-iron as a glassifier to increase the formation of the elongated amorphous regions they had observed in the material. They reasoned that shape anisotropy, and thus coercivity, was related to the presence of these amorphous micro-needles.

They discovered that the addition of boron promoted the formation of a previously unknown ternary compound: $Nd_2Fe_{14}B$. Its atomic magnetic moments are arranged so that this compound has a large magnetization. At the same time, the researchers found that, compared with neodymium-iron, coercivity had risen from 8 to 20 kOe, and that the magnetic energy product had increased by a factor of seven.

On March 31, 1987, General Motors dedicated a new Delco Remy plant in Anderson, Indiana for the production of magnetic material and finished magnets made from $Nd_2Fe_{14}B$ under the commercial name MAGNEQUENCH.

General Motors

GM

MARK OF EXCELLENCE

THE MEN BEHIND THE WORK



Dr. John Croat and Dr. Jan Herbst did their original work on rare-earth magnetic materials when both were Staff Research Scientists in the Physics Department at the General Motors Research Laboratories.

Dr. Croat (right) holds a Ph.D. in metallurgy from Iowa State University. In 1984, he joined GM's Delco Remy Division to stabilize the melt-spinning process for the commercial production of MAGNEQUENCH materials. He is currently Chief Engineer at the Indiana plant.

Dr. Herbst received his Ph.D. in Physics from Cornell University. He is now a Senior Staff Research Scientist and Manager of the Magnetic Materials Section in the Physics Department of the GM Research Laboratories. His research interests also include photo-emission theory, the physics of fluctuating valence compounds, and superconductivity.

Dr. Croat joined General Motors in 1972; Dr. Herbst in 1977.

SCIENCE/SCOPE®

Larger power requirements of advanced satellites promise to be met by a new type of battery. Hughes Aircraft Company is developing nickel-hydrogen technology for the U.S. Air Force. The new batteries will be placed on larger spacecraft now being built for customers such as the Air Force, Japan Communications Satellite Company, and INTELSAT, the internal communications consortium. A nickel-hydrogen battery the same size and weight of a conventional nickel-cadmium battery will produce more watts for more years, take more abuse, and perform well even when nearly drained of power.

Hot spots, leaks, and other potential problems in jet engines show up more readily during testing with the use of a Probeye® thermal video system by the U.S. Air Force. Six units of an advanced, third-generation version of the system, developed by Hughes, have been delivered to Arnold Air Force Station in Tennessee for use in analyzing engines undergoing performance testing. Designed for both laboratory and field applications, the all-electric thermography system provides a real-time, multi-color television display of the temperature distribution of a scene being viewed by the Probeye infrared viewer. The new version features enhanced image processing capability, a four-fold improvement in resolution, easier portability and other operational improvements that provide the user with more information for quicker, more accurate testing.

U.S. Army's Fiber Optic Guided Missile (FOG-M) uses a new winding technology to deploy its plastic-coated glass fiber. This fiber permits a two-way jam-proof communication link for transmission of television-like pictures of enemy armor and helicopters to a gunner station located in a protected position. Using technologies learned from 20 years of producing Tube-launched, Optically tracked, Wire-guided (TOW) missiles, Hughes engineers developed a method of precisely winding optical strands so that they can be dispensed at missile velocities without interruption of the data transmission. Because the optical fibers are not much larger than the thickness of a strand of human hair and are elastic and pliable, Hughes invented a device which precisely measures the elasticity of each fiber thus allowing it to be spool-wound with precision. Another Hughes technological advancement is a diagnostic instrument that detects defects in the fiber.

A flight engineering simulator will help develop new military aircraft and systems as well as improve existing ones. The system will be operated by General Dynamics, which produces the F-16 fighter for the U.S. Air Force. The simulator will help serve as proof that design concepts are feasible and allow comparisons to be made without risk of substantial capital investment. It will use technology from F/A-18 training systems developed for the U.S. Navy and Marine Corps. Hughes will supply an image generation and display system, plus operator control and equipment monitoring hardware. The simulator will include 40-foot domes, each housing General Dynamics cockpits and avionics systems.

A broad spectrum of technologies, many of which grew up within the past five years, are represented in the products of Hughes' Industrial Electronics Group. Six divisions and two subsidiaries, each operated like a small high-tech company but backed by resources of its multibillion-dollar parent, offer career benefits to qualified engineers and scientists. Advancing technologies such as microwave and millimeter-wave communications, silicon and GaAs solid-state circuitry, fiber optics, and image processing equipment are pursued in facilities located in many of Southern California's most desirable coastal communities. Send your resume to A.T. Moyer, Hughes Industrial Electronics Group, Dept. S2, P.O. Box 2999, Torrance, CA 90509. EOE. U.S. citizenship may be required.

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ROBERT C. COWEN

U.S. Should Take Lead in Preserving Biological Diversity

THERE seems little doubt that we are at the beginning of what could become a mass extinction of Earth's plant and animal species. This raises the dual question: how seriously does the projected loss threaten human welfare and what is humanity to do about it?

Neither part of the question can be answered with precision. But independent studies of the problem released this spring by the Worldwatch Institute and the congressional Office of Technology Assessment (OTA) conclude that the loss of species could become a major disaster for humanity. Earth has anywhere from several million to several tens of millions of living species. Several species are now vanishing every day. This extinction rate is expected to climb to several hundred a day in the next two decades.

Ecologists are concerned that this loss of diversity could tear the web of life in ways not yet understood. In the Worldwatch study, senior researcher Edward C. Wolf explains: "As species disappear, the intricate links between species . . . are sundered. Even ecosystem processes such as the cycling of water and nutrients . . . can be affected." Thus, the basic capacity of our planet to sustain a healthy mix of organic life could be at stake.

At best, reduction of biological diversity could mean that "resources that might otherwise improve the quality of human life will not be available," according to the OTA study. At worst, it could mean "a serious disruption of the ecological processes upon which civilization depends." In the case of food supply, the OTA report points out that exploitation of the genetic resources of wild plants accounts for about half the agricultural productivity in the United States. In spite of the promises of genetic engineering, agricultural scientists will continue to rely heavily on natural genetic resources to breed resilient and productive plants. "Loss of diversity, therefore, may undermine society's realization of the technology's potential," the report says.

Doing something about this problem will be a difficult and complex challenge.



ROBERT C. COWEN IS SCIENCE EDITOR OF THE CHRISTIAN SCIENCE MONITOR *AND FORMER PRESIDENT OF THE NATIONAL ASSOCIATION OF SCIENCE WRITERS.*



The U.S. and other nations can no longer afford to treat economic and environmental issues separately.

There are only a few cases, such as excessive whale hunting, in which the "culprits" in exterminating a species can be easily identified and their action curbed. Much species loss is an unintended result of human activity. The spread of cities destroys habitats for many plants and animals. Air and water pollution can destroy species far from the pollution sources. Swamp drainage, marshland development, and forest clearance for farming, mining, and lumber all contribute to the problem. Perhaps the biggest wholesale loss of species stems from the rapid clearance of tropical forests in Africa, Asia, and Latin America. Much of this deforestation can be attributed to the Third World's desire to export items such as cattle, rubber, tea, and bananas for cash. In addition, rapid population increases in tropical countries are forcing many more farmers to practice slash-and-burn agriculture to feed themselves. In short, unplanned development in many developing countries is destroying the very resources upon which long-term economic survival depends.

Restoring Damaged Habitats

Setting aside parklands, preserving some animal species in zoos, storing plant species in seed banks—such measures can help retain some genetic resources temporarily. But thousands of other species vanish as their habitat is disrupted. Life needs complete ecosystems to maintain a healthy diversity of species, which could mean saving hundreds of square miles of a forest area or even an entire watershed. Most national parks in the United States are too small to be used this way, and they are already losing their native species because of insufficient space as well as tourist invasions and surrounding development. An area where forest is interspersed with cleared land is not as rich an ecosystem as it would be if left intact.

Thus, a top priority in the battle against species loss is to identify key remaining wild ecosystems and try to preserve them. This should be complemented by restoration ecology—the revival of damaged habitats such as abandoned farmland. The restoration of prairie at the Fermi National Accelerator Laboratory in Batavia, Ill., illustrates this possibility on a pilot scale. The accelerator itself is underground. However, the 600-acre site will eventually support both native prairie plants and animals. The 450 acres restored so far already have much better soil structure and water-holding capacity than adjacent pasture land.

The problem of derelict land and disappearing species exists on a much larger scale in tropical regions. In Costa Rica, for example, thousands of acres of dry tropical rainforest have been destroyed to make way for development. A University of Pennsylvania team is now attempting to restore portions of the forest by using the nearby 25,935-acre Santa Rosa National Park as a source for the plants and animals originally found in the rainforest.

Humanity faces what the U.N. World Commission on Environment and Development has called "the new reality." We can no longer afford to treat economic issues and environmental issues separately. Until the need to maintain a diversity of life becomes part of economic planning in developing countries, wildlife destruction will continue. Extensive research is needed to overcome our profound ignorance of what we are doing to life on Earth. Equally extensive coopera-

Continued on page 27

ILLUSTRATION: BRUCE MADDOCKS

LESTER C. THUROW

The New American Family

SOME conservative and religious groups are trying to turn the clock back to the days when women stayed at home and men earned enough for the entire family. But those days are gone. Women's earnings today play an increasingly important role in determining whether families can afford to maintain a typical American lifestyle. In many cases, a working husband and a working wife are a must for economic survival. Groups who wish to preserve the traditional family unit would be better advised to work toward programs that reduce the strain on working parents and make dual incomes possible.

During much of the twentieth century, female earnings were not a substantial factor in the income of husband-wife families. Many women stayed home, and there was an enormous gap between male wages and wages for women who did work. From the 1930s (when figures were first available) through most of the 1970s, the earnings of full-time female workers were only 56 to 59 percent of male earnings. Such disparity persisted despite enormous increases in the number of women in the labor force and the introduction of affirmative-action programs in the 1960s. Yet by the late 1970s the earnings gap had begun to close, and by 1985 (the most recent year for which we have data) female earnings had risen to 65 percent of those of males.

Female unemployment rates were also consistently above those for males until recently. In the 1970s, unemployment rates for women over the age of 20 exceeded unemployment rates for adult men by 1.5 percent. By 1986, the two rates had reached parity, and thus far in 1987 adult female unemployment is running slightly below that of males.

Higher earnings opportunities for women are also opening up. The number of women earning more than $50,000 per year more than tripled in the last 10 years, climbing from 91,000 women in 1975 to 341,000 in 1985 (in constant 1985 dollars). Such incomes, of course, are still exceedingly rare for women; those earning more than $50,000 make up only 1 percent of all U.S. working women.



Those who wish to preserve the family should support programs that reduce the strain on working parents.

Unfortunately, female salaries are rising in proportion to male salaries not because women are doing better but because men are doing worse. Between 1975 and 1985 (after correcting for inflation), median male earnings fell 8 percent for all men and 5 percent for those who work full-time year-round. In contrast, median female earnings rose 18 percent for all women and 4 percent for those who work full-time year-round. These advances in real female earnings were actually much slower than those achieved in the previous decade when male wages were rising rapidly.

The reasons for falling male earnings are easy to find. The industries hurt most by foreign competition—autos, machine tools, steel—were precisely the industries that provided the most high-earnings jobs for men, especially men who did not go to college. With the decline of these industries, men were left with fewer good-income jobs. In the jobs they did retain, they were often forced to accept "give backs"—lower wages to keep their jobs.

That foreign competition emerged for our best jobs should come as no surprise. Those plotting foreign industrial policies were not interested in capturing the low-income service jobs traditionally held by women. Foreign ministries such as Japan's Ministry of International Trade and Industry were interested in the high-wage industries traditionally populated by men.

Furthermore, most of the growth in the American economy in the last 10 years has occurred in the service and white-collar occupations that are traditionally large employers of women. As a result, female employment opportunities are growing much faster than male employment opportunities. These female jobs are still low-paid, but with the disappearance of many high-earnings male jobs, they look better than they used to.

DINKS Set the Example

Along with the shifting trend in male and female salaries come dramatic changes in the work patterns of the American family. Of the 87 million households in the United States in 1984, 50 million were traditional intact husband-wife families. Of the 40 million husband-wife households with earnings (the rest were mostly retired), 28 million—or 70 percent—reported earnings by both husband and wife. These families had median incomes of $31,000—$22,000 earned by the husband and $9,000 earned by the wife. While the dominant pattern today is a full-time year-round husband worker and a part-time or part-year wife worker, this pattern is rapidly shifting toward a lifestyle in which both husband and wife work full-time year-round. In 1984, 11 million families had two full-time workers, and these families had a median income of $39,000: $24,000 earned by the husband and $15,000 earned by the wife.

Such statistics signal a fact of life. If a family wants the average American lifestyle, it has to have a working husband and a working wife. Only 11 percent of working men will earn $39,000 or more on their own. Only 1 percent of working women will earn $39,000 or more on their own. Without an intact husband-wife working family, few families have any chance of maintaining a middle-income lifestyle. In 1984, the average household income for those not in husband-wife families was only $12,000. Meanwhile, two-parent families are having fewer children.



ECONOMIST LESTER C. THUROW IS DEAN OF THE SLOAN SCHOOL OF MANAGEMENT AT M.I.T.

ILLUSTRATION: SOPHIE SCHILLER

COWEN

CONTINUED FROM PAGE 25

Families with a dual income and no kids (DINKS) increasingly set the economic pattern that others try to emulate.

Ironically, the increasing participation of women in the workplace is causing the incomes of those families earning the highest salaries to grow much faster than the income of the average American family. Economically, American mating is highly assortative. If one looks at the husband-wife group where both are year-round, full-time workers, a husband earning $6,000 to $7,000 per year (essentially a minimum-wage male) is most likely to be married to a female earning $6,000 to $7,000 per year. The middle-income male earning $20,000 to $25,000 per year is most likely to be married to women making $10,000 to $15,000—a middle-income female. The probability that a middle-income male will be married to a female making more than $25,000 is only 9 percent. In contrast, a man earning more than $75,000 per year is most likely to be married to a woman making over $25,000 per year. Furthermore, almost none of the working wives of such high-earning males earn less than $10,000 per year.

Given these economic trends, families with an at-home wife will increasingly find that they cannot afford the material standard of living enjoyed by those around them. Thus those who embrace the traditional two-parent family will have to embrace the working wife. She is now part of the prototypical American family.

Programs such as day care, affirmative action, and government-funded allowances for children are not threats to the new traditional family. They are services urgently needed to sustain it. And for families in which men earn low wages, they are essential. Yet the United States is one of the few industrialized nations that does not require or encourage companies to provide day care for their employees. Nor does the United States, unlike Canada, France, and the Scandinavian countries—provide monthly allowances to both rich and poor families depending upon the number of children they have.

These are surprising blind spots for a nation that makes as much noise about the virtues of the family as the United States does. Rather than focusing on putting the working wife back in the home, we would be better advised to support today's American family by promoting day care, subsidies for families with children, and affirmative action. □

tion among nations is needed to manage economic affairs in an ecologically sound manner.

Here is a field in which the United States can and should exert world leadership. Instead, the OTA reports: "The United States has begun to abdicate leadership in international conservation efforts, with the result that international initiatives are weakened or stalled." The World Bank's new commitment to take account of ecology in projects it supports is a small step toward reversing this sad trend. But with the future viability of the planet at stake, Congress and the administration must renew and strengthen this country's commitment to global conservation. The OTA suggests, for example, that Congress enact legislation making the maintenance of biological diversity a major goal of federal agencies such as the Environmental Protection Agency, the Department of Agriculture, and the Department of the Interior. □

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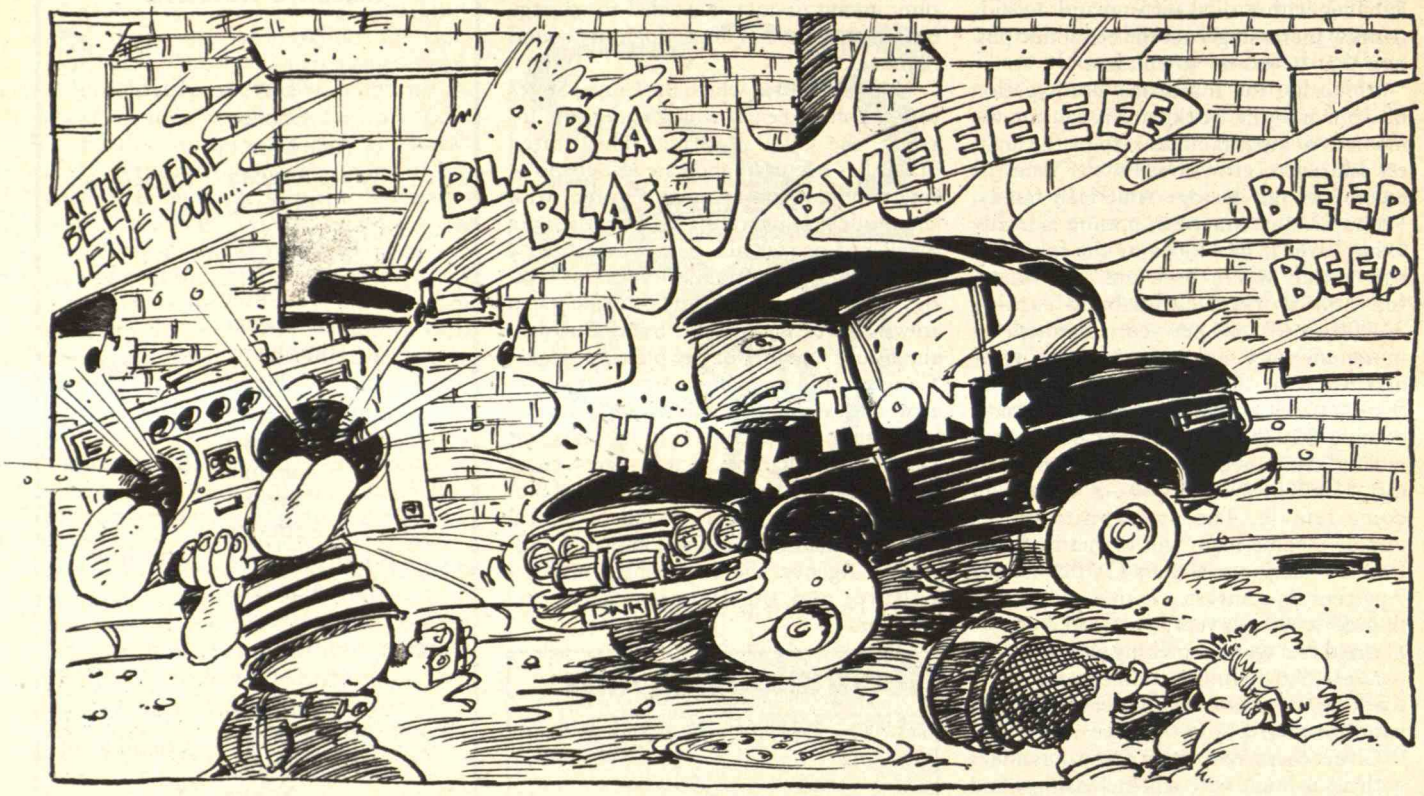
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BY DAVID LYON

Hey You! Make Way for My Technology!



At 4:30 one morning a large truck sped through my upwardly mobile neighborhood, setting off three automobile anti-theft alarms in its wake. The alarms on a two-tone Datsun and a Volvo station wagon stopped screaming within a few minutes. The piercing device on a beige Mercedes 350 SE whooped until well after 5 A.M. The local police explained that the law doesn't limit such intrusions on good citizens' hours in the arms of Morpheus. It's a fair bet that cars equipped with overly sensitive theft alarms suffer an unusually high incidence of slashed tires. One officer of the law suggested the best remedy might be a .357. "Just blow that sucker away," he advised.

Poetic justice would be served by using a forceful product of the first Industrial Revolution to silence a less brutal but no less obnoxious device from the second. Rudeness is on the rise in the United States, and consumer technology is partly to blame for this erosion of civility.

That may seem a harsh indictment for such seemingly innocuous creations as the telephone answering machine, boom box radio-cassette player, and talking computer chip in automobiles. They are hardly cutting-edge devices, but they are relatively cheap to manufacture and insinuate themselves into every corner of daily life. The result is a decline of civilization as we have known it.

Rudeness is on the rise, and consumer technology is partly to blame.

Manners and Machines

Civilization, after all, is governed by a network of rules and regulations that people subscribe to as part of the unwritten social contract. You can think of this system as a cement mixer filled with ball bearings. Without a viscous medium in which to churn, the bearings eventually grind each other down to metallic dust. The medium that keeps social friction at a minimum is the code of manners.

But manners require some attention, and the whole point of having machines do a job is to free their users from having to pay attention. As machines multiply our capacity to perform useful tasks, they boost our aptitude for thoughtless and self-centered action. Civilized behavior is predicated on the principle of one human being interacting with another, not a human being interacting with a mechanical or electronic extension of another person.

The simple telephone answering machine—an undeniable aid to the thoughtful person who doesn't want to miss a message—can turn into a devilish instrument if misused. Call screening can become the electronic equivalent of avoiding your neighbor's salutation on the street: the machine's owner can use it to avoid talking to anyone except the chosen few. It has been known to prompt retaliatory rudeness in the form of irate messages from callers who suspect they are not among the elect. I know of one dinner party host who leaves call screening on

DAVID LYON is a free-lance writer who owns an answering machine, a personal computer, and a loud diesel car.

ILLUSTRATION: JON McINTOSH

throughout the meal, making guests embarrassingly privy to what should remain private communiques.

Yet it is hard to tell which enables people to be more rude: the answering machine that screens out obnoxious calls, or the telephone that permits intrusions at all times of day and night. A.G. Bell probably never envisioned aluminum-siding salespeople, college alumni associations, or lovelorn friends when he devised the telephone. Is anything as satisfying as handing over the phone to a talkative three-year-old to chat with a "telemarketer"?

In the drive to make the telephone ever more useful, the Baby Bells are marketing a service that can make the answering machine seem like an instrument of civility. "Call waiting" is handy for the small business that can afford just one telephone, but in certain hands it permits the ultimate breach of telephone etiquette. I have a (former) friend who used to chat happily with me on the phone until a second call came in to her from a potential suitor. After a few long waits, I would hang up and call back—only to reach her answering machine. Obviously, she cared less about years of friendship than reaching out and touching Mr. Goodcall.

One good thing about telecommunicated rudeness is the opportunity to avoid it. You can always hang up. Too bad there isn't such a simple escape from the most pervasive instrument of uncivil behavior, the automobile. Our forebears probably endured a breed of surly, road-hogging oxen that cut off other drivers' carts, but what whip-wielding teamster could match the arrogance and gall of a BMW driver in city traffic? The various high-tech enhancements of luxury sedans and muscle cars seem to have rendered turn signals inoperative. Does each new vehicle retailing for more than $15,000 contain a brainwave generator that turns a tweedy, bearded professor into a satanic finger-waver the moment he climbs into the lumbar-support driver's seat?

The "best" of these new cars employ outstanding design and state-of-the-art materials to insulate the driver more hermetically than ever from the environment and the other hapless humans who inhabit it. Interaction with the road now seems to follow the rules of the jungle: perversely chaotic righthand turns from left lanes, horn blasts that imitate enraged bull elephants, and rapacious disregard for any flesh that dares interrupt the mating charge of the turbo-powered road warrior behind blinding yellow fog lights.

Technology's Seductive Ways

The automobile and a host of other devices such as the telephoto lens, Walkman radio and cassette deck, and personal computer might be classified as "attractive nuisances." They are fun to use but they can stomp all over politesse. Witness the teenager on a subway car armed with 100 decibels of IC-chip rhythm in the package known colloquially as a boom box.

Most amateur photographers will attest to the value of the current generation of powerful zoom lenses—products of computer-aided design in most cases. An 80-to-200-millimeter zoom lens is usually the first accessory a budding Cartier-Bresson buys. But what cost in dignity does the zoom telephoto lens exact? Where is the civility in photographing the picturesque poor from a comfortable distance of 100 yards or more? Do privacy and respect survive the beach photographer shooting down-home cheesecake with a 1,000-millimeter lens?

Long-lens photography may arise from a generous impulse to avoid intrusion. But the impulse is misguided. It merely keeps the photographer from having to obtain permission from the subject. Similarly, the Walkman listener may be trying to avoid inflicting his or her musical taste on the rest of us, but try getting the attention of someone blissed-out on Vivaldi when he is standing on your foot in a crowd.

The explosion of personal-computer technology has spawned a vigorous rudeness that would be impossible without list and word processing. Once upon a time people wrote real letters to each other; form letters arrived only from companies that promised you could win a Cadillac and have it parked at P.O. Box 800. Now every family with a home computer can generate its own "personalized" holiday form letter. The truly technophilic may include the image of a computer-drawn sleigh on the outside of the folded missive, made possible by drastic improvements in dot-matrix printers and aggressive marketing of desktop publishing.

Practitioners of these "arts" will defend them, no doubt, on the grounds that some communication is better than none. But is a pretense of personal rapport good enough? Some product designers seem to think so, but remember that they are enculturated with the prison-camp lexicon of computer-programming languages.

Faking good manners debases the concept of polite behavior, yet thanks to cheap microcomputers and voice-synthesizing circuitry, fake manners abound. Automobile makers install polite and resonant voices that nag us to close the car door and buckle up. "Fasten your seatbelt *please*," says the voice chip. At supermarket check-out lines, kids dulled by hours of running bar-coded packages over magnetic devices sullenly hand out computer-printed receipts that say "thank you." "Thank you" and "please" have never meant so little.

Nor do the machines that mindlessly supply these markers of civility fool anyone. The automated bank teller that flashes "have a nice day" is an annoyance. Worse yet is the babbling vending machine. When a talking cola machine and a traditional, silent machine stood next to each other at Hampton Beach, N.H., last summer, the silent machine sold out first. Most beachgoers preferred to avoid the mechanized chatter and phony politeness. Score one for civility. □

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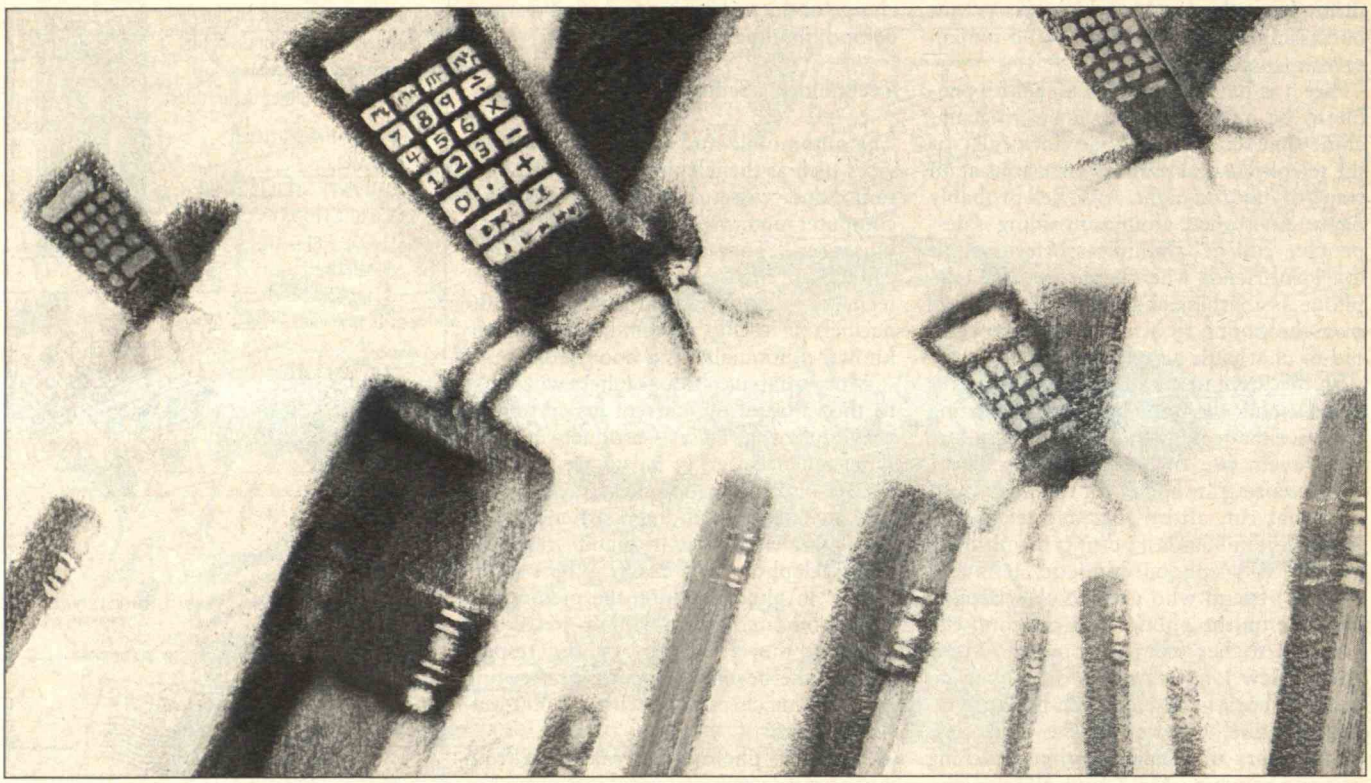
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BY ANTHONY RALSTON

Let Them Use Calculators



IN 1929 L.P. Benezet, superintendent of schools in Manchester, N.H., wrote to a fellow superintendent, "If I had my way, I would omit arithmetic from the first six grades. I would allow the children to practice making change with imitation money, if you wish, but outside of making change, where does an 11-year-old have to use arithmetic?"

This wasn't just talk. By the fall of 1933 the Manchester elementary schools had installed a curriculum that included no formal arithmetic instruction until the sixth grade. In the early years, students focused on such practical matters as money, time, and measurement. In 1935, Benezet concluded that the students had an enhanced ability to read problems intelligently and explain how they should be attacked.

In the 1980s we are in the midst of a "back to basics" movement in education. In mathematics this has meant a return to emphasizing drill in the four arithmetic operations: addition, subtraction, multiplication, and division. This focus is in reaction to the fact that too many people do not know how to do the simplest arithmetic operations—at a time when our technological society requires a knowledge of mathematics in an ever larger number of jobs.

Fewer children would be turned off to mathematics if they did less arithmetic drill early on.

However, Benezet's perception in 1929 remains on target in 1987. Drill bores good students and turns off far too many children to mathematics. What is needed is not rote mastery of skills, but rather a curriculum that focuses on understanding mathematics so that it can be used to solve real-world problems.

In the past, three justifications were given for teaching arithmetic to young children. Being able to do calculations by hand was useful in everyday life and necessary for many jobs. It was also necessary for advancing to higher mathematics. And clearly instructors *could* teach arithmetic skills to young children.

But in this day of cheap calculators, the first justification has disappeared. Being a good arithmetician is no longer necessary in daily life. As for the second justification, there is no evidence of a significant correlation between paper-and-pencil arithmetic skills and an ability to understand higher mathematics. My intuition, and that of most mathematics educators, is that the level of arithmetic skill we attempt to achieve is far greater than necessary. Moreover, the work of the psychologist Jean Piaget suggests that children in the first three or four grades of school are generally not capable of conceptualizing the

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ILLUSTRATION: KEVIN HAWKES

We need a curriculum that focuses on understanding mathematics.

arithmetic processes that they will need for later mathematics studies.

What Should Children Learn?

By the end of elementary school, children should have three kinds of mathematical ability. They should be able to do simple arithmetic mentally and to estimate answers to more complex arithmetic problems. Most important, they should be capable of deciding which of the four operations applies to a particular problem.

It will always be more efficient to do simple arithmetic mentally than to use a calculator. For all other computations we should let children use calculators. After all, outside the classroom calculators are used for almost all arithmetic.

By sixth grade, children should be able to recognize when an answer can't be right. Failure to enter a decimal point when given the task of multiplying 97.2 by 46.8 on a calculator might result in 45,489.6 instead of the correct 4,548.96, for example. Children—and adults—should be able to realize that since each multiplier is less than 100, the answer can't be greater than 10,000. The ability to estimate won't eliminate errors but it will prevent large ones.

Surely in this day of calculators it is more valuable to know what operation needs to be performed than to be able to do the computation by hand. Yet many researchers have reported the difficulties students have deciding which operation is needed to solve word problems. For example, children who have no difficulty doing pure computation have been reported to stumble when, told that a signpost is 18 miles west of Boston and 23 east of Worcester, Mass., they are asked how far apart the cities are.

A New Curriculum

To teach these concepts, a new elementary school arithmetic curriculum is needed. The first three or four years should be devoted to informal instruction. Children should focus on becoming familiar with simple numerical problems through the practical activities Benezet emphasized—making change, telling time, and measuring. Doing arithmetic mentally should be stressed and estimation introduced. The meanings of the arithmetic operations should be informally discussed and children introduced to other branches of mathematics, such as geometry. Learning to recognize shapes helps children to understand better the world around them.

The emphasis throughout the early years should be on the qualitative rather than the quantitative. For example, children might be introduced to the notions of probability and data analysis by a hands-on experiment in which they are shown two covered urns. The teacher would explain that one urn contains twice as many white balls as black while the other contains the reverse. Then balls would be drawn alternately from each urn, and the number of white and black balls drawn from each urn tabulated. The children would learn to estimate which urn had more white balls and vice versa. In this way, children would figure out how to make informed guesses without doing a lot of computation.

And the students would be discovering that mathematics is an experimental science. Most people consider mathematics analytical, in contrast to such sciences as biology, chemistry, and physics. But experimentation has always been part of the field, and today the calculator and computer are increasing the variety and sophistication of mathematical experiments. For example, by studying computer-generated mathematical patterns, researchers can develop hypotheses that they then try to prove.

As children's cognitive abilities develop in the fourth and fifth grades, they can be taught how to solve more complex problems that require arithmetic. Collecting and analyzing data that can be processed with calculators but not by hand can be the source of many concrete problems. For example, children can collect information about the gas mileage of their family automobiles and compare it with the figures published by the Environmental Protection Agency. The development of mental arithmetic and estimation ability should also continue.

Paper-and-pencil arithmetic skills can be taught in the upper grades for two- and three-digit number problems—as a crutch when a calculator is not handy. I believe that students aged 10 or 11 will be able to learn such skills easily because of the insight gained from much experience with arithmetic done mentally.

Of course, introducing a curriculum such as this will not work unless elementary schoolteachers, many of whom feel insecure about mathematics, can be supported through teacher training and in-service courses.

More Reading and 'Riting

Probably one result of such a curriculum would be fewer total hours devoted to arithmetic in the early elementary grades. What should be done in the time made available? I believe there should be more instruction in reading and writing, given the terrible writing skills of most of the high-school graduates whose work I see. One of Benezet's motivations for his experiment was that he was "distressed at the inability of the average child in our grades to use the English language." Many mathematics educators believe that one reason some students do badly solving problems is that they can't read well. Making time for more reading instruction in the early grades may well improve students' performance in mathematics later.

Won't my proposal to reduce the amount of mathematics instruction in the early grades worsen U.S. children's relatively poor performance on standard mathematics tests? Recent studies have documented these problems. A study published last year in *Science* by Harold W. Stevenson and others showed that U.S. first graders were behind Japanese and Taiwanese children of the same age in mathematical understanding despite similar cognitive abilities. By the fifth grade the gap had widened considerably. And the Second International Mathematical Study, conducted by an international group of mathematics teachers in 1982 and published this year, found that American junior and senior high-school students were average or below-average in mathematical ability compared with students in 21 other countries.

I believe that the curriculum I have outlined can only improve the relative abilities of U.S. children. At the end of eighth grade, students would not only have learned all the mathematics required for future study, but fewer would be turned off to the subject. I think that an increased percentage of students would be not just willing but anxious to take more than the required mathematics in secondary school. They would thus prepare themselves better for entering the job market or for studying college subjects that require high levels of proficiency. If we don't move quickly, our children's mathematics training will continue to suffer. □



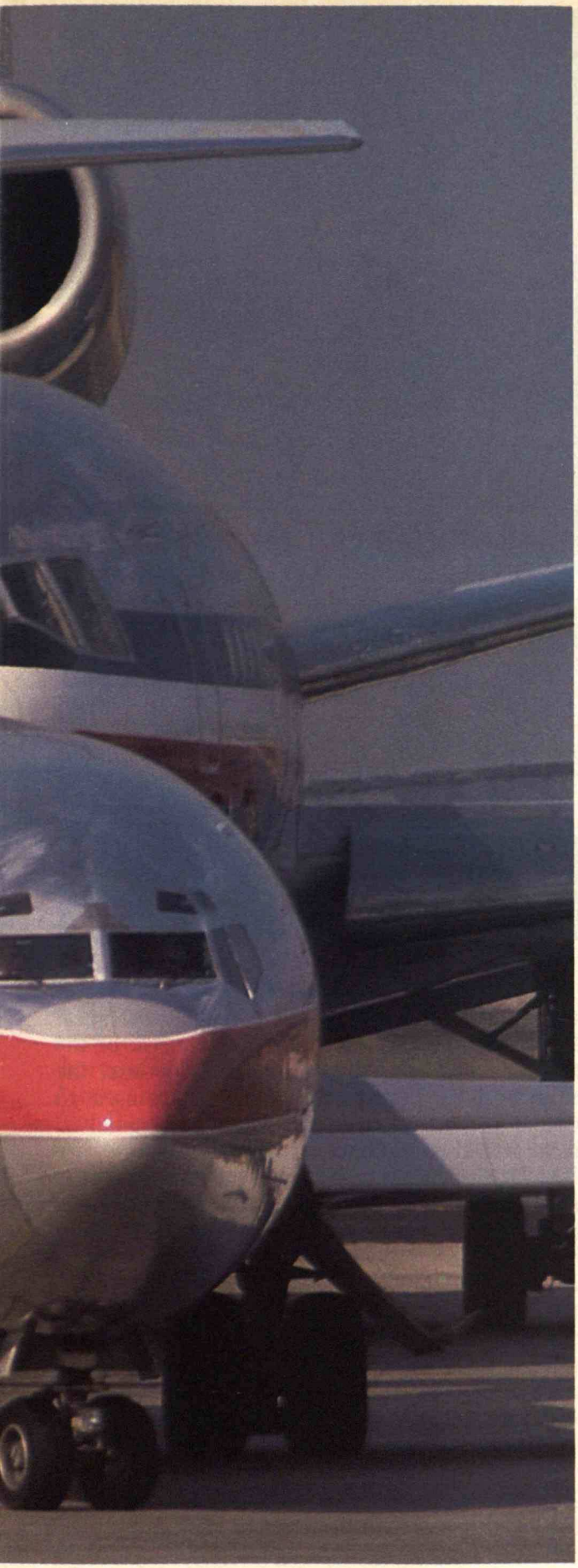


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Deregulation has made safety a cost-accountable item, and the margin of safety is shrinking.

AVIATION SAFETY: Fact or Fiction

THE good safety record that U.S. airlines now enjoy results not only from more than five decades of regulation but—more importantly—from the sizable margin of safety that carriers have maintained above required levels. The public has taken for granted the fact that the safety margin exceeds the minimum standards and expects that margin to be continued. But has it been maintained in this period of deregulation? I suggest that it has not.

Airlines followed stringent economic regulations under the Civil Aeronautics Act of 1938 and the Federal Aviation Act of 1958. These acts also dictated minimum standards for granting operating certificates to aircraft and flight crews, and they further enunciated "the duty resting upon air carriers to perform their services with the highest possible degree of safety in the public interest." Those laws specifically governed safety in civil aeronautics, and the costs of maintaining high safety standards were built into regulated fare levels.

Yet the Airline Deregulation Act of 1978 has greatly accelerated the cost-cutting drive that started with the fuel crisis in the early 1970s. Under dereg-

BY ROBERT REED GRAY



ulation, anyone can start an airline and operate anywhere in the United States. The result is that the number of certificated carriers rose from 39 in 1978 to 124 in 1984. In 1987, the General Accounting Office (GAO) told Congress, "The flood of new airlines and accompanying competitive fares . . . pressured airlines to contain expenditures for aircraft maintenance, flight crew salaries, and other controllable expenses."

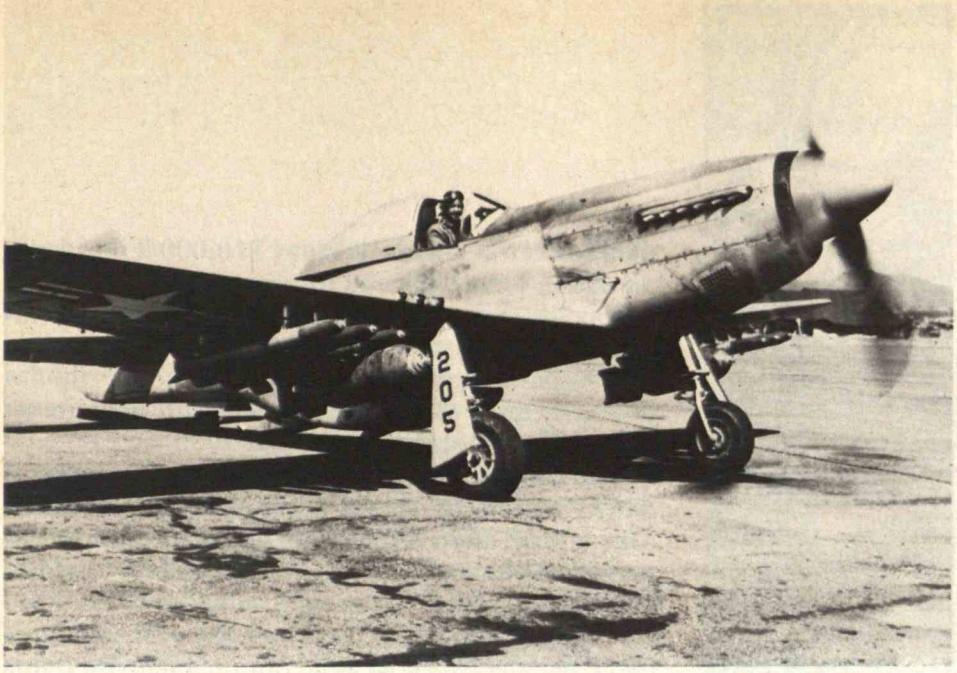
Many new carriers have little notion of or experience in how an airline must be run. Moreover, before deregulation, an applicant for a certificate to operate a scheduled airline had to prove its financial fitness—its ability to operate on a profitable basis—to the Civil Aeronautics Board (CAB). The CAB took that mandate seriously. Since deregulation, questions of profitability are considered the risk of the entrepreneur. The CAB and, after its demise, the Department of Transportation (DOT) refused to consider the safety ramifications of a marginal or uneconomical operation.

The DOT is belatedly beginning to recognize that financial fitness is a true safety concern. But the FAA, which is part of the DOT, has not risen to the challenge of deregulation with enough staff to make sure that the increasing number of airlines conform to safety regulations. Between 1978 and 1983, the FAA *cut* the number of its inspectors by 34 percent—from more than 2,000 to 1,332—as a cost-saving measure. At the same time, the workload increased tremendously because the number of air-carrier aircraft also increased—from about 2,800 in 1978 to about 4,200 in 1984.

In 1984—six years after deregulation—the FAA announced it was hiring some 180 new inspectors. That move simply edged the agency back toward its

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PHOTO: BOB STRAUSS/WOODFIN CAMP & ASSOC.



The shortage of experienced commercial pilots is exacerbated as those trained in World War II and the Korean War retire.

1978 staffing level. As of May 1986, the FAA Flight Standards Division employed only 1,610 inspectors—still 400 fewer than in 1978. And the airlines are buying even more aircraft.

In many other areas, the margin between what federal regulations require and what carriers provide has been narrowing because of the need to cut costs to remain or become competitive. Safety can be maintained, but only if the airlines, the Congress, the administration, and the FAA face the problems now, rather than waiting for accidents to occur.

Who Will Fly Tomorrow's Planes?

One of the most immediate concerns arising from the growing number of airlines and flights is an alarming shortage of well-trained pilots. The current shortage exacerbates a problem that already existed. Airlines hired a number of military pilots after World War II and the Korean War, with the biggest boom in 1966. Those senior pilots are now either retired or facing retirement and must be replaced. Thus, the numerous carriers must now bid for the services of a limited number of qualified pilots. In 1978 airlines hired about 2,700 pilots. They hired 5,700 in 1984, 7,800 in 1985, and 6,300 in 1986.

Since seasoned pilots are hard to find, the experience level of new pilots is decreasing. Some major carriers no longer require that pilots have a college degree and are reducing age, vision, height, and experience standards. Moreover, new airlines pay below established rates, and most major airlines now have a lower pay scale for new hires. Citing Continental's lower pay scales since its 1983 bankruptcy, Northwest reopened talks this year with its pilot and flight-attendant unions. Northwest's chairman, Steven Rothmeier, says that to remain competitive, "we must have lower pay rates for new employees." Last year, Continental employees reportedly averaged $22,155 per year; Northwest employees, $33,655. It is only reasonable to expect that when you pay less, you get less.

According to *Aviation Daily,* 13 percent of the new pilots hired by major airlines in 1986 had under 2,000 hours of flight time. Two years earlier, virtually no new pilot hired by a major airline had so little experience. In general, pilots have less experience in different operating environments and weather before being promoted to captain.

More experience needs to be required before pilots can be upgraded to first officer or captain. The 1982 Air Florida accident in a snowstorm in Washington, D.C., is a case in point. The captain had about 8,000 hours of flight time, but he had logged most of this experience as a DC-3 captain in Florida. Air Florida upgraded him to a B-737 captain in less than two years, and he had only about 1,500 hours in the new aircraft, with no real cold-weather experience. The National Transportation Safety Board (NTSB), which investigates air accidents, noted in its report that major trunk carriers then took an average of 14 years to upgrade a pilot to captain. The report commented that the Air Florida captain did not have the normal seasoning experience of a first officer.

The problem is more than just a shortage of experienced pilots. Before deregulation, pilots tended to stay with one carrier rather than lose the seniority benefits that union contracts conferred. These contracts are now often voided and their protections eliminated as carriers declare bankruptcy and reorganize. Moreover, few, if any, new carriers have pilots' unions. For good reason, pilots appear more

PHOTO: U.S. AIR FORCE FROM ASSOCIATED PRESS



The captain of the Air Florida plane that crashed in a Washington snowstorm had little cold-weather experience.

interested in a carrier's financial stability than in seniority—witness the reported defections from People Express when its profitability faltered.

As a result, pilots are changing airlines more often, and each time one shifts, both the old employer and the new carrier incur training costs bringing new pilots up to standard. The NTSB investigation into the 1983 Air Illinois crash revealed that carrier-hopping was a problem. The carrier had experienced a 60 percent turnover in flight personnel for its commuter operation over a two-year period. *Aviation Daily* cited an even more shocking statistic in August 1985: "Demand for pilots by larger carriers has been devastating for regional airlines, some of which have had a 125 percent attrition rate in a 12-month period." It is difficult to comprehend how a carrier can operate with a 125 percent attrition rate, much less with the margin of safety the public expects.

Airline moves to stem carrier-hopping indicate how seriously they take it. For example, American Airlines reportedly requires that new hires under their lower "B" pay scale repay $10,000 if they leave American before the end of a year's employment.

Solving the pilot shortage may require an increased government role rather than the decreasing role suggested by deregulation. If the airlines do not police themselves, the government will have to set more stringent standards.

One temporary solution could be to raise the mandatory retirement age for pilots, say from 60 to 62. This would allow airlines to retain their most experienced pilots and give the carriers a bit of breathing room to attack the general shortage of qualified personnel. Tougher medical and physical standards could be established to weed out the high-risk pilots among this older group. A number of pilots have recently sought exemption from the age-60 rule and have proposed medical standards whereby they could continue to qualify. The FAA has not yet acted on this request, but a blanket refusal may spur a court fight, congressional action, or both.

A civilian pilot training program similar to that developed by the U.S. government just before World War II would help alleviate the shortage over the long term. Any such program should require trainees to enter commercial aviation for a certain number of years or to reimburse the government for training costs. As an alternative, airlines could pay contractors to train more pilots, as some foreign carriers now do.

Regardless of how the pool of pilots is expanded, in my view experience requirements for these employees must be increased. At present, all one needs to qualify as a B-747 captain is to be 23 years old, have 1,500 flight hours, and have a rating for that type of aircraft. Different requirements can and should be set for first hires at each category of airline and for upgrading to captain. In fact, the Air Line Pilots Association recently asked the FAA to increase flight experience requirements for pilots on larger aircraft.

Who Will Service the Planes?

The shortage of skilled mechanics is almost as severe as that of pilots. More mechanics are needed to service the increasing number of aircraft under deregulation. And, like pilots, mechanics are switching carriers far more often than they used to—again with implications for safety.

According to a 1985 article in *Air Transport World,* "Aside from the love of aviation and appre-

PHOTOS: BENN/COULSON, MIKE YAMASHITA/BOTH FROM WOODFIN CAMP

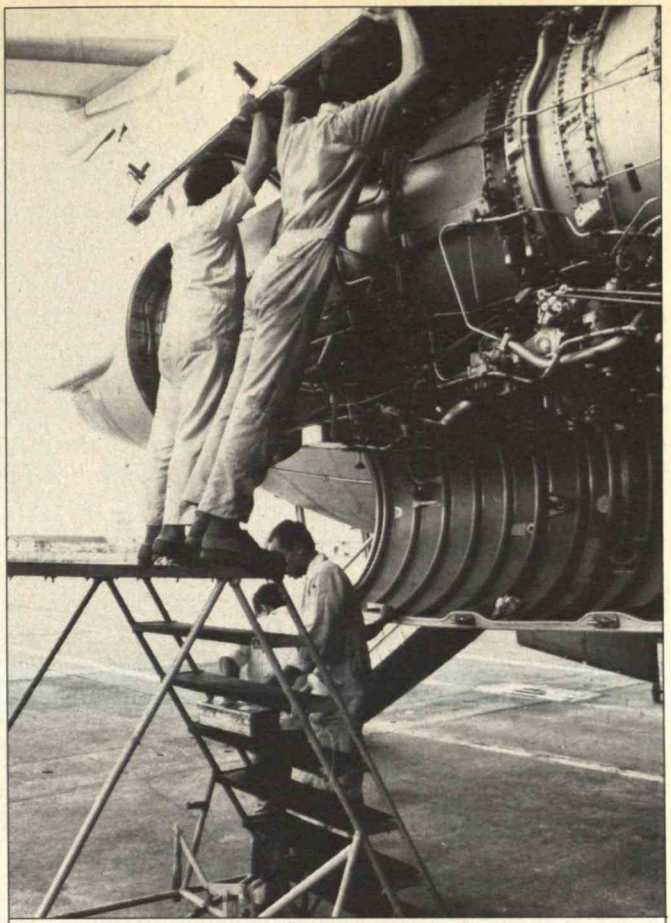
ciation of the travel benefits associated with airline work, there are not a lot of financial inducements to encourage those with mechanical skills. A mechanic with good basic training from technical school has the choice of beginning . . . in general aviation working for around $6 per hour or getting $12–$14 per hour at an auto dealership." The article singled out an unnamed large regional carrier that offered a starting wage of $4.50. Of course, such an airline would have trouble finding mechanics.

Maintenance departments may not be doing the job they used to. Recently, the FAA has cited major carriers both for violating record-keeping regulations and using improper or nonstandard parts. Aircraft have operated with pieces of wing flap missing or passenger doors that are difficult to close properly. And many carriers, particularly new ones, are subcontracting a substantial portion, if not all, of their maintenance. This makes it harder to keep standards high and creates surveillance problems for the FAA. In its Air Florida accident report, the NTSB considered this a matter of increasing concern.

In addition to having problems with maintenance, established carriers are reportedly shrinking internal safety departments and aircraft engineering staffs, while new carriers have little incentive to establish such departments. Without engineering staffs, airlines cannot give as much input to aircraft manufacturers. Jack Enders, president of the Flight Safety Foundation, noted, "Faced with the economic survival decisions brought about by recession and sharp competition from deregulation, many airline managements have had no choice but to reduce expenditures in the rear lines, while continuing the vital front line functions of operating and maintenance."

This, said Enders, tends to leave the burden of all aspects of aircraft design on manufacturers, who do not themselves operate aircraft on tight schedules or inspect the operations and maintenance of the air carriers. Thus, in 1986 Joseph Sutton, executive vice-president of Boeing, urged renewed "airline participation in the development of operational and certification criteria" and "in-depth technical and operational guidance to manufacturers in the design of new aircraft."

FAA regulators cannot help because their own research budgets have been reduced. Moreover, the GAO noted that retirements of engineers and technicians are hitting the FAA as hard as they are the airlines. As Sutton observed, "For American aviation to progress, it is essential that the major regulatory agency be equipped with sufficient expertise to keep pace with advancements in technology."



The shortage of skilled mechanics is almost as severe as that of pilots.

More Work for Fewer Inspectors

FAA has a related problem with its work force responsible for safety inspections. Recently, Transportation Secretary Elizabeth Dole promised to increase this work force by 500 by 1988. But she has yet to explain how these new inspectors will be trained and qualified.

Like the airlines, the FAA is finding it hard to obtain personnel of the proper quality and experience. It will take substantial time to train replacement inspectors—as well as the new hires that Dole says will come on board to augment the inspection force. It will take even more time for new inspectors to gain the field seasoning necessary to replace those who have retired. Less qualified people will be inspecting and regulating a less qualified and greatly expanded industry.

Fewer fully qualified air-traffic controllers are responsible for more airplanes.

The NTSB investigation of the Air Illinois accident—and the attendant publicity on the shortcomings of the FAA's inspection of that carrier—forced the FAA to address the problem of the increasing workload for a smaller inspection force. The FAA conducted intensive safety inspections after the Air Illinois hearings and uncovered a large number of violations at both large and small airlines. The FAA shut down a number of commuter carriers until they came up to snuff, and some actually went out of business. FAA chief Donald Engen told an American Bar Association meeting in October 1986 that inspections in the previous two years had led the FAA to suspend or revoke 121 operating certificates, as well as to impose large civil penalties.

Yet there is a disconcerting aspect to such statistics: the FAA often did not discover safety problems until a disgruntled airline employee became an informant. In the case of Provincetown-Boston Airways, FAA teams did not uncover significant violations—such as pilots flying without current ratings—despite a number of inspections. And even after an informant led the FAA deeper, it took 10 inspectors eight days to make the case for revoking the carrier's certificate.

When safety inspections are inadequate and management is not strongly committed to safety, problems will slip by or, in the most flagrant cases, be hidden willfully from inspectors. There are instances in which aircraft had to be completely overhauled after being repossessed from bankrupt carriers or returned after a lease period. In some instances, improper or nonstandard replacement parts had been used. Yet these aircraft—defects and all—had apparently been flown in scheduled service.

Perhaps higher FAA visibility and tougher penalties for flagrant cases are needed. John Cassady, assistant chief counsel of the FAA's Regulations and Enforcement Division, told the Federal Bar Association that making it clear to the industry that the FAA "is on the job" is essential. Publicity is another key. No carrier can long withstand a reputation that it cuts corners on safety. But unless the FAA inspects the airlines and reveals violations, bad publicity comes only after an accident.

The present law allows a maximum penalty of only $1,000 for a safety violation, with each day of a continuing violation constituting a separate violation. That level was introduced in the Civil Aeronautics Act in 1938. While it may have been substantial then, it certainly means less now. In 1985 Sen. Nancy Kassebaum (R-Kan.) introduced a bill at the request of Secretary Dole to increase the penalty to $10,000 per violation. And in early 1987, Rep. Guy Molinari (R.-N.Y.) introduced a comparable bill, but nothing has come of the matter yet.

One reason for Congress's inaction on the bills may be that the FAA has shown a willingness to impose stiffer penalties in the past year. Recent fines imposed on major carriers have totaled millions of dollars, although the potential penalty, at $1,000 per violation, was tens of millions of dollars. For example, Eastern Airlines' recent $9.5 million penalty was based on a potential $78.4 million charge.

The real problem lies with penalty limits in the case of *willful* violations. Certainly $10,000 a day per violation is reasonable if records are falsified or an operation is conducted in willful violation of safety regulations. Those situations may well require higher penalties and the possibility of a jail term for airline personnel, including corporate executives.

The Traffic Control Problem

Compounding FAA's inspection shortcomings are the difficulties the agency has with its air-traffic-control (ATC) system. Again, fewer fully qualified controllers are responsible for more airplanes.

In 1981, the FAA employed 16,000 controllers. At that point, the government fired a substantial portion of the controller work force to end a strike. FAA now has only about 14,000 controllers, and the number who are fully qualified is in dispute. The FAA has been able to keep things fairly well in hand with flow control—that is, keeping aircraft on the ground until they are assured of a straight shot into a landing at the destination. Congestion on the ground is safer than congestion in the air.

However, the airlines are concerned that flow control and delayed flights impose too much of an economic burden because of increased crew costs and inefficient use of aircraft. Flight delays were up almost 25 percent in 1986 from the previous year, and rose another 11 percent in the first three months of 1987. Airlines appear more willing to accept possible holding delays in the air because destination congestion often clears up faster than expected.

Yet concern about flow control ignores the essential problems of the ATC system, as well as the ultimate capacity of airports to accept more flights.



Not only is the controller force below the authorized target, but the process of hiring new controllers is going more slowly than the administration anticipated. The result: in 1985, the GAO reported that "controllers and supervisors believe that workload pressures are mounting to a point where it will be difficult to maintain the existing level of system safety." Installation of the FAA's answer to its controller cutbacks—a $16 billion computer system called the National Airspace System (NAS)—is way behind schedule. In 1987 the GAO reported that installations of portions of the NAS "have experienced schedule delays ranging from one to eight years." Although most of NAS's advanced technology is not yet operating, airlines are now pressuring the FAA to reduce some aircraft-separation standards to help reduce flight delays.

Moreover, the ATC system has not been redesigned to account for the crowding problems inherent in the current practice of "hubbing." Many flights pass through a hub airport where passengers make connections for a number of other destinations. Because of hubbing, the FAA estimates there will be a million more departures annually by 1995.

Re-Regulating Safety

One of the most pathetic claims of the deregulationists is that "we didn't deregulate safety." The fact is that from a practical standpoint they did. They failed to tell Congress that more inspectors, controllers, pilots, and mechanics would be needed. They did not ask Congress to appropriate more money to train the additional FAA staff. They did not tell Congress that steps were needed to maintain safety in the face of what would become an increasing shortage of highly qualified airline personnel.

When Congress deregulated the airline industry, it also hit the FAA with budget restrictions that prevented the agency from training a new cadre of safety inspectors. Had the FAA been given the necessary funding in 1978 when the Airline Deregulation Act was passed, it would now have had almost a decade to hire and train the necessary inspection force, rather than having to start from scratch as it now must.

Simply put, when Congress deregulated the airline industry, it failed to take into account the fact that safety had never been a cost-accountable item. By

PHOTO: ANTHONY ROLLO/WOODFIN CAMP

Those who raised the issue of safety in the pre-deregulation debate have been proved correct.

opening the market to unlimited competition, Congress made everything cost-accountable, including safety.

Each of these problems, whether those of the airlines or the FAA, is cause for concern. Now—not later—is the time to face up to these difficult matters.

In at least one area—that of financial fitness—DOT has recently begun to improve. Three examples come to mind.

First, in April 1986 DOT began to investigate Galaxy Airline's continuing financial and managerial health. Galaxy had had two accidents in January 1985, one at Reno, Nev., and one at Dobbins Air Force Base in Georgia, and Congress exerted tremendous pressure on DOT to act. Before allowing Galaxy to continue its operations, the agency demanded far more detailed evidence of its continuing fitness than is asked of a brand-new airline.

Second, in July 1986, after the FAA found LA Helicopters, Inc., to be financially fit, the agency discovered that the airline had presented a different financial and operational program when it applied to the FAA for an operating certificate. DOT demanded and received a satisfactory explanation before it allowed the company's commuter air-carrier registration to become effective.

Third, in the case of applicants for new certificates, DOT appears to be taking a much harder look at economic data and is insisting that the numbers add up. Indeed, when it issued a regulation in May 1987 requiring the filing of financial data by U.S. airlines, DOT essentially admitted the relationship between profitability and safety.

In my opinion, this new concern has been prompted by a realization that the margin of air safety is declining. It is a backhanded acknowledgement that those who raised the issue of safety in the pre-deregulation debate were, in fact, correct.

The FAA is trying to increase its inspection and controller force, but as recently as this May, the FAA's Donald Engen warned that the Senate's budget resolution for next year would allow "no increase in controllers in the face of 6 percent traffic growth; no increase in safety inspectors and security staff in the face of known workload."

Congress has finally awakened to what it has wrought through deregulation. But despite almost weekly hearings on the subject, it has yet to face up to the tough question of appropriating money to do the job right. □



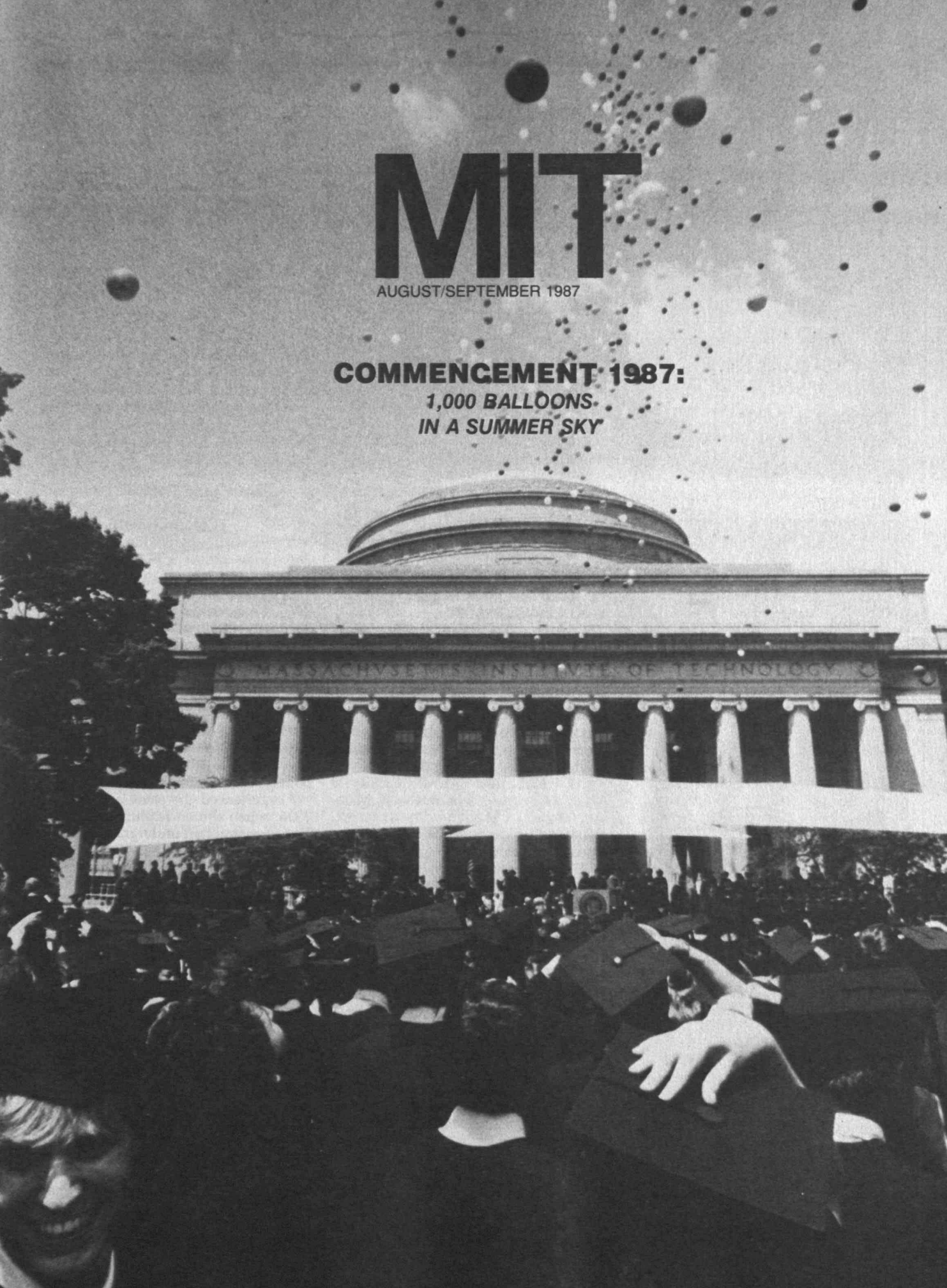
PHOTO: GEORGE HALL/WOODFIN CAMP

MIT

AUGUST/SEPTEMBER 1987

COMMENCEMENT 1987:

1,000 BALLOONS IN A SUMMER SKY



MIT
AUGUST/SEPTEMBER 1987

COMMENCEMENT 4

TING SEARCHES FOR FUNDAMENTAL FORCE 11

UNDER THE DOMES 15
Space University coming
Harbison wins pulitzer
Grad students rate M.I.T.

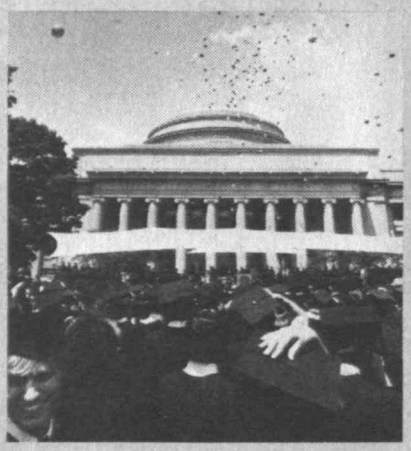
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Hughes supports students
A night at the theater

CLASSES 21

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Heroine biologist

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ABOUT THE COVER
Hundreds of balloons joined the mortarboards thrown into the air to mark the conclusion of this year's Commencement ceremony and the welcoming of the new grads into the academic community. It was a picture perfect occasion—the weather, the element that conforms to no scenario, cooperated with all the elements that do. (Photo: Barry Hetherington)

LETTERS
TO THE EDITOR


TECHNOLOGY.
MASSACHUSETTS INSTITUTE OF TECHNOLOGY.
Words by Clarence Renshaw. Music by Lloyd B. Haworth.

"FOUNDED ON SCIENCE, GIRDED WITH ART"

This song, "Technology" (*above*), appears in the 1902 edition of *Songs of Eastern Colleges*. That was well before my time at M.I.T., but at least in the 1920s I don't believe I ever heard of it. Somehow, from the words, I don't think it would be considered hot stuff by the current generation of M.I.T.ers. Does anybody know anything about it?

WILLIAM BAUMRUCKER, '29
Marblehead, Mass.

Clarence Renshaw, to whom the words are attributed, was a member of the Class of 1899, and Lloyd Haworth, who wrote the music, 1902. But Warren Seamans, director of the M.I.T. Museum who—so far as we know—is the ultimate authority on such things, can shed no light on this one. Can any reader?—Ed.

THE OPENING SALVO

At precisely the same time that we were preparing an article on changes in the humanities distribution requirement at MIT (facing page), the following letter arrived from an alumnus. It responds to an article in another publication, but relates to subject matter already mentioned in the Review *that will also be dealt with at some length in the October issue.*

Mr. Hum has strong views on what constitutes a valuable education, based on his life experience and his years in industry. We know that other alumni and alumnae do as well. It is our hope that they will use the letters column to exchange a broad range of ideas and opinions, as the renewal of the undergraduate experience proceeds.

Dear Fellow Alumni:

In the June issue of *Science*, I ran across an article titled "Curriculum Reform Sparks Debate at MIT." Periodically someone raises the same story: M.I.T. students do not know how to get along with their fellow workers out in industry; therefore they must take some courses in the humanities. Balderdash!

I experienced the same argument in 1936, when the curriculum was modified to ensure that undergraduates took some humanities courses. The first such course I took was one on marriage. I remember that students packed into 10-250 like sardines to hear the words of wisdom on marriage; but I lost all interest in the course when I heard that the professor had gone through two or three marriages himself. Then I took navigation, and found that I would never be a navigator. Finally, I took a course on social psychology by Professor Douglas McGregor, who later left Tech to become the president of Antioch College.

I believe that the humanities courses that Tech students are required to take are a waste of time. They are promulgated by an academic staff who have never been out in the "real world." In my 50 years in engineering, science, and administration, I have worked from the shop floor to the upper levels of management. I found that the most useful courses are in psychology, finance, budgeting, and cost effectiveness.

The people who get ahead in this world are not the engineers, but people who deal in money. Look at your MBAs. It's not what you know technically that counts, but how you juggle finances.

JACK K.Y. HUM,'38
Berkeley, Cal.

WHICH CREW?

The photo labeled "the official photo of the 1941 crew," (*March, page MIT 8*) is not what it's advertised to be. It is the varsity crew photo in the 1941 *Technique*, but that makes it a record of the 1940 heavyweight crew. Coxswain Mike Biancardi and number seven oar Bob Church were both members of the Class of 1940; bow man Phil Phaneuf was '42; and the rest of the crew were members of the the Class of 1941. The stroke pictured in the photo should be familiar to alumni—he is Joseph Gavin, '41, immediate past president of the Alumni Association. For the true 1941 crew, one would have to look in the 1942 *Technique*.

For the record, all six of the 1942 classmates in that varsity crew were four-year ROTC students and served active duty during World War II.

ROBERT W. BLAKE, '41
Seattle, Wash.

IS PUZZLE SACRED?

Perhaps the editors of *Technology Review* do not dare tread into the domain of the Puzzle. Or are the editors all too young to question either (a) a gross error, or (b) a venture into copyright matters. Whatever the reason, the mention of "Kupie" dolls (*Feb/March, page MIT 46, problem F/M 5*) reflects the generation gap more than anything since the shift from slide rules to pocket calculators at M.I.T.

The name was "Kewpie," written thus. No chance of choice in spelling.

Alas, the literature of my youth (and the dolls of my female contemporaries) treated so cavalierly.

ALAN W. KATZENSTEIN, '42
Larchmont, N.Y.

(An error is an error, wherever it occurs, and a correction is always appreciated.-Ed.)

Toward Richer Experiences in Humanities and Social Science

The faculty gave its approval late last spring to two changes in programs in the humanities and social sciences that affect all undergraduates who will enter M.I.T. in the fall of 1988 and thereafter:

☐ Though unchanged in classroom hours and credits, the humanities, arts, and social science core requirement for graduation has been strengthened by reducing the number and increasing the coherence of the options by which students can fulfill the distribution portion of the requirement.

☐ A new "minor" program provides for all undergraduates the option of deeper humanistic experience coordinated with their professional studies.

The changes are the first result of an ongoing reexamination of the undergraduate academic experience at M.I.T.

Professor Margaret L.A. MacVicar, '65, dean for undergraduate education and a principal architect of the undergraduate review, stresses that the changes approved by the faculty represent only a beginning of the effort to bring about a more integrated educational experience for M.I.T. students.

The overall goal, she says, is an approach that combines technical expertise with a sense of social responsibility and that includes interdisciplinary courses taught jointly by faculty members from the humanistic disciplines and the technical ones.

The dean of humanities and social science is charged with the responsibility and authority to implement and maintain the new distribution requirement, relying for advice and recommendations on a committee, or committees, of faculty members and student represenatives to be established by the dean.

A key portion of the new requirement reads: "The committee(s) will consider proposed subjects and will encourage the design of new subjects, including interdisciplinary ones. Each subject will be reviewed by the committee(s) every three years for continued eligibility as a distribution subject."

The faculty directed that the five thematic categories across which students' choices must spread should "incorporate where appropriate materials and insights drawn from the full range of contemporary scholarship, including that on women, minorities, and non-western cultures." In addition, specific provision was made in the categories for the inclusion of language acquisition studies and the visual arts.

The five categories in the new requirement are: Literary and Textual Studies; Language, Thought, and Value; The Arts; Cultures and Societies; and Historical Studies.

The essence of the new distribution requirement, MacVicar says, lies in the commitment of M.I.T. to develop and sustain a limited set of specially designated subjects whose purpose is to introduce more effectively the breadth of approach and diversity of knowledge necessary to a student who might "never take another subject in that area of learning."

The minor in humanities and social science, developed through collaboration of the School of Engineering and the School of Humanities and Social Science, will be the first such program available to all undergraduates. Building on the eight-subject humanities requirement, a student will elect a grouped set of subjects providing an in-depth exposure to a field of concentration within the humanities and social sciences.

Although the minor will be designed to minimize overloading the four-year academic program, the tiered nature of the groups of subjects approved as minors will be much more demanding and penetrating than most undergraduates now experience.

According to its sponsors, this proposal gives new weight to the humanities, arts, and social science disciplines, especially in an engineering education. MacVicar says she believes that "we will look back on the establishment of the HASS minor as the first step in a truly new thrust toward a richer, more complex tapestry of academic programs for our students." ☐

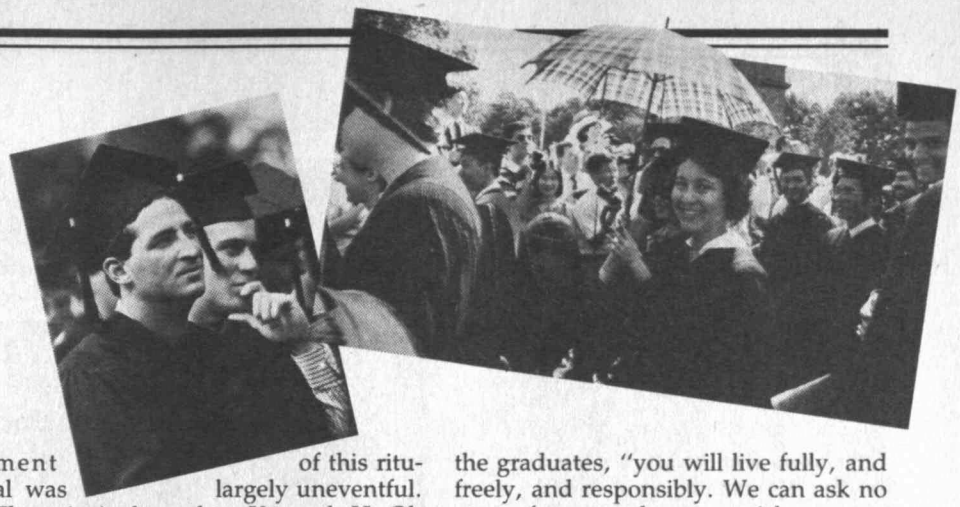


Commencement 1987

One Ceremony; 1,762 Records of Achievement

Once a year, typically on the first Monday in June, M.I.T. abandons its hard-won reputation for rationality and intensity for a ceremony that would mystify any visitor from a wholly foreign culture: some 8,000 people assemble under the open sky, rain (1986) or shine (1987), while 2,000 men and women in curiously decorated robes, mostly black, and platformed hats make their way across the campus in a 50-minute procession largely unseen by the audience. When the marchers are seated, there follow several orations and then another 75 minutes of marching, as 1,750 of the robed dignitaries file across a stage one by one. Finally the whole assembly dissolves, alternately clustering in varied small groups in front of people holding lensed devices and aimlessly wandering about the grounds eating small morsels, while the crews that built it begin immediately to dissassemble the ceremonial site that took at least a month to prepare.

Despite its apparent incongruity, this anomaly in the community life has vital purposes. Chiefly, of course, it is to honor those who have completed M.I.T.'s prodigious educational demands and won re-



lease from a purgatory of problem sets, all-nighters, and the final obligations of one of the transitions to adulthood. But two other purposes are served: Commencement gives M.I.T. one more chance to build its image of institutional excellence, and the graduates have an opportunity to offer their thanks to those whose investments of tens of thousands of dollars have made it all possible.

For veteran Commencement-watchers such as the writer, the 1987 re-enactment of this ritual was largely uneventful. The principal speaker, Kenneth H. Olsen, '50, president of Digital Equipment Corp., commended to the graduates the philosophy that has guided him as one of the nation's outstanding entrepreneurs: "Running a business is not the important thing," he said. The vital commitments are "to do the whole job, . . . to improve things, to influence the world."



Summarizing his career since he left M.I.T. to found Digital Equipment Corp. in 1957, Olsen said his biggest problem has been to retain the spirit of entrepreneurship as the company grew and diversified. His solution has been to break the company up into "a number of entrepreneurial product lines. . . . When people have complete responsibility for their part, they do very well. When they make mistakes, they correct them. And the effectiveness of people in charge, when they feel responsible, feel creative, is truly impressive.

"The challenge I face today is to have more than 100,000 people working together in one direction and still maintain the entrepreneurial spirit," Olsen told the graduates. "And the challenge we have as a society is to do that in all our organizations. . . . I think many of you have demonstrated that people . . . will often jump at the chance to take responsibility for a segment of a business or a school if the goals are clear and they can take part in planning and are given the freedom to take risks."

In his charge to the graduates, President Paul E. Gray, '54, joined Olsen in emphasizing the role of integrity. Gray spoke of "the intellectual integrity that stems from the best in scholarship and scientific inquiry: the clear vision and honesty that come from examining questions with an open mind, of following the evidence rather than finding data to support a preconceived idea, of incorporating the dissonant information and learning from it rather than ignoring it because it doesn't fit."

"If you engage the world with the full measure of your integrity," Gray told the graduates, "you will live fully, and freely, and responsibly. We can ask no more *of* you—and we can wish no more *for* you."

Gray's address was interrupted—and for many in the audience made largely inaudible—by whistle blowing from a small group of dissidents representing such diverse causes as women's rights, minority education, South African divestment, and Cambridgeport development, causes on which a number of students have accused Gray of inadequate commitment during the year. The whistle blowers, who included some of the graduates, moved through the audience, making them difficult to round up; Campus Police estimated their number at 10 to 20, but organizers claimed more than twice that. Other graduates had messages pinned to their gowns urging divestment.

Grace W. Ueng, '87, president of the class, made no mention of these issues when she presented the Class of 1987 gift—funds for a combination map and direction and announcement board to be erected opposite 77 Massachusetts Avenue. The goal, she said, is to make M.I.T. more accessible for future students and visitors. The project is the result of gifts of $4,895 from members of the Class of 1987, an amount matched by the 50-year Class of 1937. (A score of red-jacketed 1937 grads marched at Commencement to applause from the audience.)

Furthermore, Ueng said, she and her classmates have pledged gifts of $29,775 over the next four years.

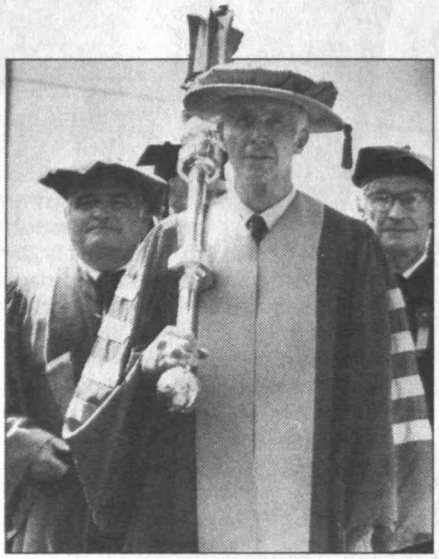
The speaking program completed, the president and John M. Deutch, '61, provost, turned to the task of delivering a total of 1,929 degrees to 1,762 graduates, 413 of them women. It's an organizational feat of some magnitude, supervised for the last 36 years by Warren D. Wells, '48, registrar. But 1987 was Wells's last year to orchestrate the event: he retired on July 1, to be succeeded as registrar by David S. Wiley, '61, formerly associate dean for student affairs.

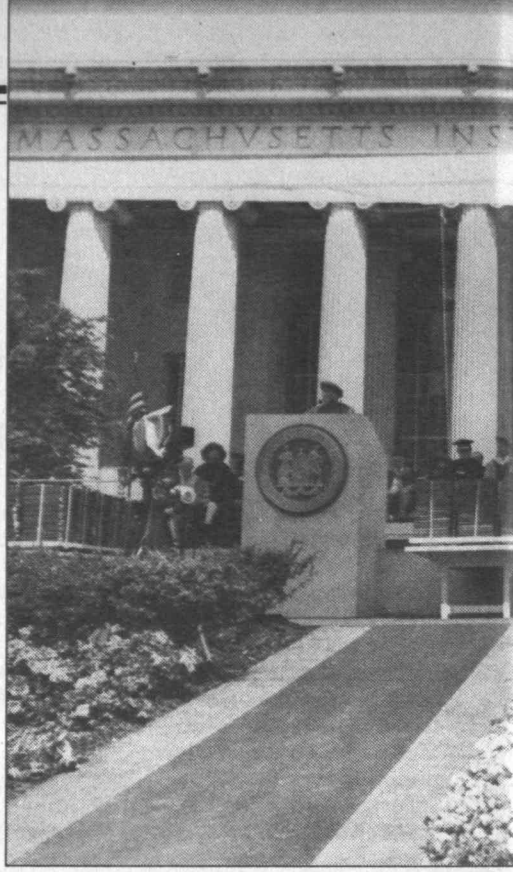
Hidden behind the degrees are un-

Continued on page MIT 11

COMMENCEMENT PHOTOS: DONNA COVENY, BARRY HETHERINGTON; ILLUSTRATION: BRUCE MADDOCKS







The photos may be black and white, but the pageant they document is in full color: the multi-hued faculty regalia; the cardinal and gray robes of Alumni Association President Joseph Gavin, '41 (immediate right) President Paul Gray, '54 and Corporation Chairman David Saxon, '41 (right and left, behind Gavin, respectively); the banks of flowers; and the red jackets of (right to left) H. A. Zimmerman, Philip Peters, and Richard Young, as they led fellow members of the 50-year reunion class of 1937 in the procession.

Above All, Integrity

The following is the charge to the graduates delivered by President Paul E. Gray, '54, at Commencement Exercises on June. 1.

This is the moment.

You have just completed the most rigorous and demanding university education in the country. Today, we all gather to celebrate your accomplishments and to welcome you into that legendary band of survivors known as M.I.T. alumni.

Congratulations!

Now anyone who has successfully completed this intellectual tour de force may well consider that experience the ultimate test of the individual. But you know and I know that you have not reached this moment by yourselves. We are joined today by those remarkable people who have been stalwart members of your winning team over the past four—and more—years. I speak, of course, of your families and friends. You and M.I.T. owe them a profound debt of gratitude.

And so I would ask the graduates to please stand and face the audience, so that you can join with me and the faculty in applauding those whose sacrifices and loving support have made this day possible.

There is much debate today—at M.I.T. and in the society at large—about the role of higher education, and about its relation to the knowledge and values necessary to sustain you far into the next century. I suspect each member of the faculty would come to this debate with a slightly different view. But let me offer you, briefly, my own thoughts on this matter.

As you leave here, you will spend your professional lives working under circumstances in which the linkages among science, technology, and human affairs bear directly on your work, and in which the ethical and moral consequences of your decisions will be part of what it means to be a professional.

What does this future require of your education?

My own view is that education should enable an individual to live fully, and freely, and *responsibly* in the world. An education for our times—for the future—must include the many ways of perceiving, understanding, and communicating that at any time and in any place allow access to the world in which we live. The power of education comes not only from an ability to explore the natural and social orders from a variety of perspectives but from an ability to *integrate,* easily and unself-consciously, the knowledge gained from those explorations. Such an education will give you freedom. And it will give you the power to act responsibly.

The key here, I believe, is this matter of integration, of intellectual integrity. The ability to deal with your world, personally and professionally, in an integrated, holistic manner is of paramount importance for you—and for the rest of us whose lives will be influenced by your ambitions and achievements.

As I look at the condition of our society today, I am struck over and over by the need for integrity. By this I mean, first, the intellectual integrity that stems from the best in scholarship and scientific inquiry: the clear vision and honesty that come from examining questions with an open mind, from following the evidence rather than finding data to support a preconceived idea, from incorporating the dissonant information and learning from it rather than ignoring it because it doesn't fit.

An important part of what you have learned here is how to isolate problems, how to disaggregate complex matters into simpler elements, and how to develop models to test your ideas and theories. You have learned how to simplify problems for the purpose of study. But these very same skills can also be a trap—a trap that illustrates a second as-





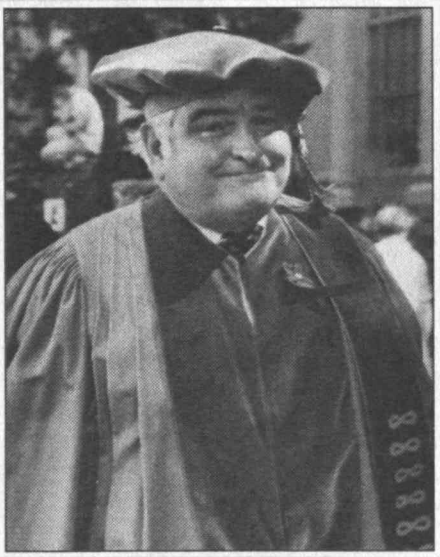
pect of the need for integrity.

The simplified problem, after all, is rarely the real problem. The *reality* of the world is that the *problems* of the world are woven together in the fabric of day-to-day life. Technical and ethical issues *are* integrated. The isolation of problems is a useful and necessary construct, but it is a construct nonetheless. The challenge to the practitioner is to comprehend the problem in its larger, more complicated context—in short, to view the problem, its possible solutions, and their consequences in a comprehensive manner, and in a manner that is intellectually honest. This requires the ability, and the inclination, to tie together various domains of knowledge and experience—to draw the connections and analogies, and to act on the logical consequences.

Why do I see this as so important to your future—to our future? The news is filled these days with examples of institutions and people who have failed—in some cases betrayed—the public good.

I submit that this failure stems from an absence of the kind of intellectual integrity I have been talking about. Let me give you just two examples.

The first is the agony and the tragedy of Roger Boisjoly, the Morton-Thiokol engineer who worked on the seals for the space shuttle Challenger. In a talk here last winter he described the conflict between the company management and the engineers who were urging delay of



the rocket launch because of the possibility that the seals could fail under low-temperature conditions. The engineers' warnings were resisted by NASA officials and dismissed by the management of their own company. We will never forget the consequences.

Why, we should ask, didn't the company management encourage—rather than overrule—Dr. Boisjoly and his colleagues? What kind of message did that send about professional responsibility? As engineers, as managers, as professionals in any domain, our responsibility must encompass the public good. If we are in the service of the public good, then professional practice requires us to be concerned with the consequences, ethical *and* technical, of the information we develop and the decisions we make. It is a question of integrity—for individuals and for institutions as well.

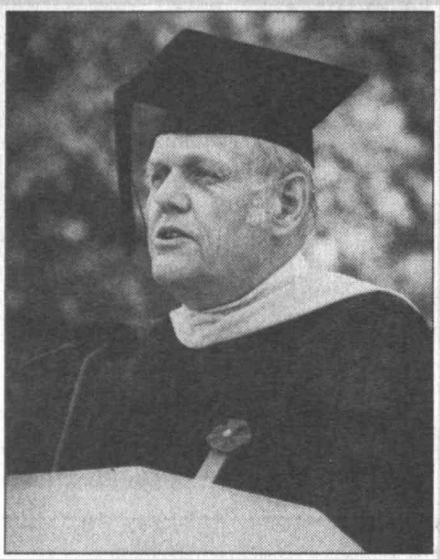
The second example, more recent, is that of Robert Owen, the aide to Oliver North who recently testified at the Iran-Contra hearings in Congress. Here is a bright, sincere, idealistic young man who truly believes in the cause of the Contras, who believes that he himself was fighting for the cause of democracy in that country. Because of his conviction in the rightness of his cause, he took part in activities that subverted the process of democracy in *this* country. Incredibly, he did not see the contradiction. He did not see the ironic relation between his actions and the principles he thought he was supporting. For him, the end justified the means. Again, it is a question of integrity.

I give you these examples because they are current—and all too real—symbols of the world you are about to enter. It is a gritty, complex, paradoxical place. It is exhilarating, messy, filled with joy and pain. It is the only world we have. If you engage this world with the full measure of your integrity, you will live fully, and freely, and responsibly. We can ask no more of you—and we can wish no more for you.

Good luck and Godspeed. □



The Spirit of Entrepreneurship



Following is the condensed text of the address by Kenneth H. Olsen, '50, founder and president of Digital Equipment Corp., at the Graduation Exercises on June 1.

We received a good education at M.I.T. when I attended the Institute—a surprisingly pertinent education. I can even say I learned double-entry bookkeeping from Samuelson's economics book. But there was one thing missing: we were never taught any theory or any philosophy of work, anything about job satisfaction or what to look for.

Ed Schein, an industrial psychologist at the Sloan School, once said that work is the most important thing in a person's life. Yet the job was one thing we very rarely talked about.

I can't in 20 minutes answer that need, but entrepreneurship, the arena in which I have worked since leaving M.I.T. 30 years ago, does offer an interesting model around which to think about one's job and one's goals in a job. The place of entrepreneurship in our society is obvious. Traditional enterprises are reluctant to gamble on new ideas and new approaches, to pay the price for competition. It is the place of the entrepreneur to do these things.

When I left M.I.T., I had attained just about all of my dreams. I had done more research—far more elegant research with far more resources—than I had ever imagined. At $12,000 a year I was able to feed my family. I had everything that I wanted.

But one thing was missing. Nobody cared. We felt we had to prove something to the world: the power of interactive computing. Normal computing at the time was considered big, expensive, and awesome—beyond ordinary people. Interactive computing, in which people could interact directly with the computer, was exciting and fun. We had demonstrated its usefulness at M.I.T., and it was our dream to show the world what it could do. But the industrial world didn't care; they said we were too academic. (I'm afraid that's what we say about M.I.T. today.)

We had found at M.I.T. a trusting, generous attitude, and at the same time a tremendously competitive intellectual atmosphere that was very productive and a great deal of fun. There was a team spirit—everyone knew the goals and everyone worked towards them. So, in addition to demonstrating our technical ideas, my early business partners and I wanted to prove that this environment could work outside M.I.T.

Entrepreneurship and the Long View

When I and my partners Stanley Olsen and Harlan Anderson, decided to start a company we went to the American Research and Development Corp. (AR&D) in Boston. Our first contacts (AR&D) told us that this was not the right time for starting a company: the country was heading into a recession, and electronic companies launched during the Korean War were not doing well. But they invited us to make a proposal to their Board of Directors, and they gave us three pieces of advice:

☐ Don't use the word computer, because *Fortune* Magazine said no one is making money in computers. So we took the word computer out of our proposal. (The lesson there of course is that you have to be adaptable and you have to sell your ideas.)

☐ The promise of five per cent profit on sales in our initial presentation is not high enough; raise it. We had learned by reading in the Lexington Library that all good companies seemed to make five per cent profits, but now we promised 10 per cent. And we made 10 per cent most of the time. (The lesson there is obvious: if you aim for a low number, you surely will not make a high goal.)

☐ Promise fast results, because most of the board members were over 80. So we promised to make a profit in one year. (Just as with a home budget, a business budget without short-term goals encourages spending more money than is coming in.)

The AR&D Board bought our plan and gave us $70,000 in capital. With that, they owned more than 70 percent of the company. But the investor gave us freedom and didn't interfere, either to straighten out things when they were going poorly or to exploit things when they were going well. AR&D definitely took a long view; they wanted their investment to produce something useful for society.

We never finished our business plan. We didn't have a big volume of spread sheets and dozens of colored graphs. We had only simple profit and loss statements and balance sheets. But AR&D could see that our financial plans were in our heads and in our hearts, that we made them, understood them, and remembered them, and that they were simple enough to be a model with which we could run the company daily, weekly, and monthly.

Today, when plans are drawn up by computer or by staff, they have more detail than you can keep in your head, and as a result, they lose their usefulness. The nice thing about $70,000 is that you can watch every dollar.

We learned a lot in those early years. We moved into an old mill where we paid 25 cents per square foot per year for space with watchman service and heat. We did everything ourselves, from building the offices to moving the equipment. We did the photography in my

basement. We printed our circuits with real silk on wooden frames and etched them in aquarium tanks we bought from the five and ten. We sometimes spilled the etching solution onto the furniture store below—I think we bought the same set of furniture several times. We had the opportunity to learn accounting and all the steps in manufacturing—things that, in time, became very valuable because they made us sensitive to the people in many different jobs.

Accounting More Expensive Than Manufacturing

When we met with our accountants, we said we wanted big-company accounting. In our very humble offices, with lawn furniture and a leftover rolltop desk, that took a little bit of convincing. And when they set up the system, we discovered that it cost us more to do the accounting than it did to do the manufacturing.

After we were in business 12 months, we indeed had made a profit—not much, but a profit. We very proudly went down to show our report to General Georges Doriot, president of AR&D. He looked it over, and then he looked up, scowling: no one ever had succeeded this soon and survived, he said. He had watched many people start companies, he said, and found that success almost completely destroys entrepreneurial spirit. Doriot believed that success stops a company from taking risks; the successful entrepreneur delegates the profit-and-loss statement to staff or to a computer so he (or she) doesn't see it every day, and the founders lose the humility necessary to learn.

The traditions of science and of the church hold that humility is necessary if one is to learn. And I believe that's correct: humility that comes with the spirit of learning, probing, experimenting, trying, doing, redoing, and redoing again is the only way to keep improving most things, particularly in the world of elegant technology.

After a few years we had to face the question of how to introduce the spirit of entrepreneurship throughout the company. We were doing well. We had grown to be a $14-million company. No one wanted to make changes. We had become a company of people who were full of ideas of what other people should do, full of ideas of where we should spend money and what products we should make. But there was only one entrepreneur at the top.

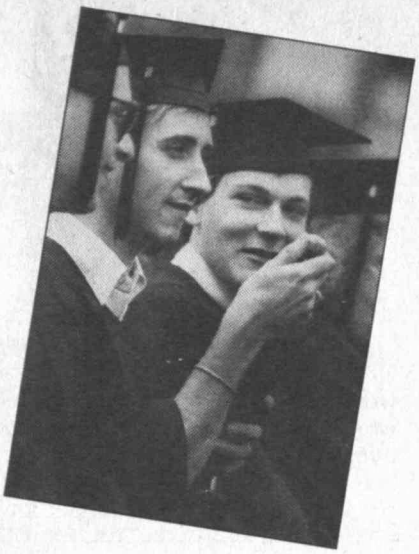
To solve the problem we broke the company up into a number of entrepreneurial product lines. Each one had a manager with complete responsibility for that segment of the business, and everyone else served that manager. This went over like a lead balloon. Everybody thought they were being demoted. Many people quit; even some of the board resigned. But the results were magnificent. Within a year we had doubled our profit without hiring anybody. For many years afterwards we grew at the rate of 20, 30, 40 percent a year and made very good profit. The reason is obvious. When people have complete responsibility for their part, they do very well. When they make mistakes, they correct them. And the effectiveness of people in charge when they feel responsibility, feel creative, is truly impressive.

We had been warned that in such a highly competitive, entrepreneurial enterprise, with people competing against the outside world as well as against those inside, there would be a tendency to sacrifice ethics in order to succeed. I was therefore delighted, if somewhat surprised, to find that, to an overwhelming degree, people prefer to be ethical and to work for an ethical company. People are honest with the company when the company is honest with them, and people are honest with suppliers and customers when they know that the company is not interested in unethical profiteering.

The challenge to us as a society is to maintain the entrepreneurial spirit in all our organizations.

For a number of years now we in the

Continued on page MIT 10









It was a day for light-heartedness: Ken Olsen, '50 (lower left), hamming it up for the camera; graduates throwing caps in the air; receptions under balloon-festooned striped awnings. And a day for families: proud young parent/graduates; an appropriately-clad toddler greeting Provost John Deutch, '61; and the "thoroughly M.I.T. family" of Mark Wang, '87 (see accompanying article).

Continued from page MIT 9

western world have been in competition with Communism—our economic freedom versus their controlled economies. We have won the contest hands down. No thinking person will argue for the Communist approach. Yet we are in disarray.

When members of the American business community get together, it's quite common to snicker at the failure of Communism—the central planning, the absolute intolerance of duplication or competition, the fear of risk taking, the lack of motivation and direct rewards that devastate Communist economies. But back in the American companies, there is central planning, aversion to risk taking, no duplication, no competition, and rewards that are not directly tied to risk taking.

We read that Gorbachev would like to explore economic freedom for his country. We realize that he has limitations, that he has to convince his staff first. We wish he had more freedom.

The American business leader has the same problem. He might like to try internal competition, for example. But as you can guess, he has staff that are very well educated, have been taught all the analytical skills, know how to use computers, and have all the qualifications to be brilliant in the conclusions they come to. But they are averse to risk taking, internal competition, or any of the entrepreneurial activities that are so fruitful.

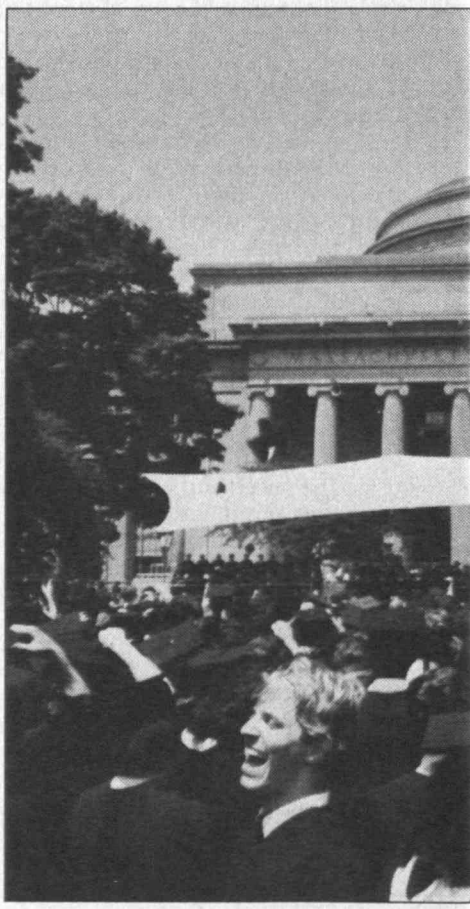
A few weeks ago I was sitting between a minister of state and a translator in the Great Hall in China. All of the conversation was done through the translator until I asked one question: How is it that China has gone so quickly from having a shortage to having a surplus of food? The minister came back instantly: "We have reforms." He knew how much a farmer received for a chicken, how much a farmer was paid for an egg, and how many chickens were needed for the farmer to earn more than a minister. We have very little of that spirit in our country, despite our claims of economic freedom.

Many people who don't want to run their own businesses will jump at the chance to take responsibility for a segment of a business or a school. That happens when they understand the goals clearly, when they can take part in planning, and when they are given the freedom to take risks.

Sometime—I hope a long time from now, when I have to tell people that I'm leaving my job—they will say to me, "Ken, why don't you stay another year? It has been so much fun, so challenging working for you."

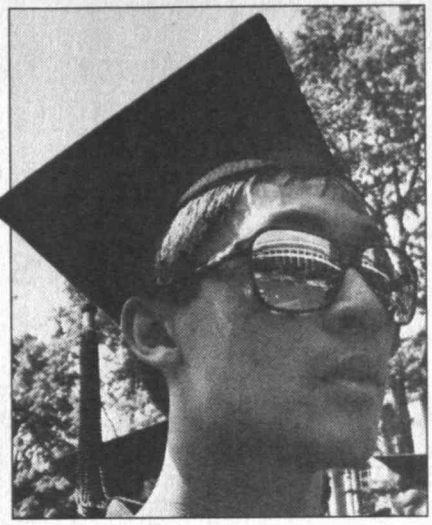
My ambition is to leave when they are still saying that, when I can be remembered as someone who challenged them, who influenced them to be creative and enjoy work and have fun for a long time. □



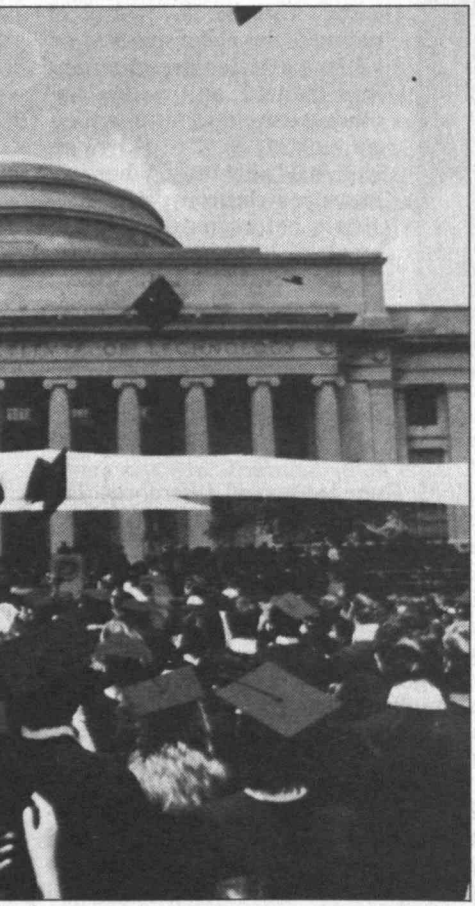


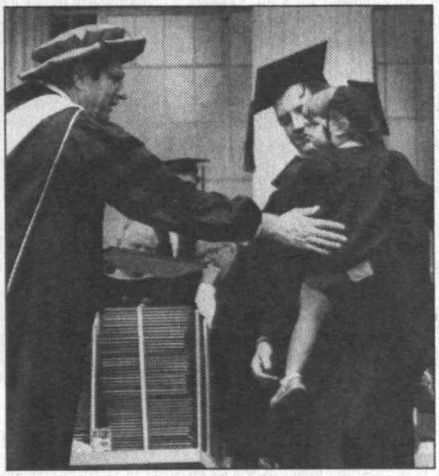












Continued from page MIT 5

seen accomplishments and histories of which only hints are given by the 200-page Commencement program. Consider just three examples:

Matthew C. Wiener, '87 received S.B. degrees in humanities and mathematics. Fluent in Russian, Wiener wrote an undergraduate thesis on the impact of the computer on Soviet government policy—the result of a year spent in the U.S.S.R. He hopes to continue his studies and research somewhere behind the Iron Curtain next fall.

John S. Langford, '79, received his fourth M.I.T. degree on June 1—a Ph.D. awarded jointly in aeronautics and astronautics and political science. Langford spent last year with the Institute for Defense Analyses in Alexandria, Va., and his thesis is a study of federal investments in aeronautical research and development and their results. But Langford is better known as the head of the Project Daedalus team that holds the world record for human-powered flight and now is deep in the effort to fly from Crete to Greece.

And Mark Y.D. Wang, '87, S.B. in physics and mathematics, marched into Killian Court knowing that for his parents there was an extra edge to the usual pride of families watching the ceremony. Ru-Liang Wang, Sc.D.'65, and Chieh-Chun Wang, MCP '61, were married in the M.I.T. Chapel on July 22, 1961, and Mark is the first of their three children to follow in their footsteps by earning a degree from the Institute. However, Mark's sister, Cindy, expects to receive a bachelor's degree in chemistry and biology in 1989, and his brother, Frank, is enrolled in a doctoral program in math. (Mark himself is now a graduate student in physics at M.I.T.) As far as anyone knows, the Wangs are on their way to being the only nuclear family to all hold M.I.T. degrees. (*Photo accompanies this article*).—*John Mattill* □

A Nobel Laureate Searches for the Fundamental Force

By Jean P. Flanagan



Samuel C.C. Ting, professor of physics, shared the 1976 Nobel Prize for Physics with Professor Burton Richter of the Stanford Linear Accelerator Center for their simultaneous but independent discoveries of the "J/psi" particle, a new elementary particle of the atom. Now Ting is leading a major new experiment with an international team. (*See accompanying article*). It will utilize facilities of CERN in Geneva, Switzerland, and its administrative and scientific base is in the M.I.T. Laboratory for Nuclear Science (LNS). In this interview, Jean Priestley Flanagan, an administrative staff member at LNS, discusses with Ting the L3 experiment and the implications for physics of such vast programs and the massive machines they involve.

FLANAGAN: You are leading a consortium of 400 scientists that will mount the largest of the experiments for the world's largest particle accelerator, now nearing completion at CERN. What made you undertake such a huge collaboration?

TING: What we want to do is a very precise experiment with high-energy photons, electrons, and muons. With higher energies and more particles, detectors grow bigger and more complex and experiments become more complicated. We need a lot of people in all phases of the work. The ideal would be a small accelerator—the experiment would be far simpler. But with current technology there is no other way.

FLANAGAN: What specifically do you want to do?

TING: There are so many things we do not yet know in high-energy physics. If you look at developments in particle physics over the last 30 years, most of the major discoveries are associated with muons or electrons. The discovery of the fourth quark, which we call the "J" particle, was made by the precision measurement of electron pairs. The discovery of the fifth quark, the so-called "beauty," by Leon Lederman [Director of Fermilab, Batavia, Ill.] was made by the measurement of muon pairs. The Z^0 intermediate boson was found by studying electron pairs. The discovery of the W particle was made by measuring electrons and muons produced at a large angle with respect to a particle beam. We will be trying to extend these discoveries by studying the high-energy muons and electrons created in the collisions in the new CERN accelerator—and to measure precisely their energy and the direction of their movement.

What will we find? We do not know for sure. High-energy physics is at the frontier of science. When we do a new experiment we always find something unexpected.

For example, take the work by James Cronin and Val Fitch in the early 1960s. They were looking for K mesons, neutral unstable particles with masses approximately half that of a proton. Nobody thought they would find anything new. But they did a precise experiment and made the important discovery that the symmetry of nature is not always preserved when particles are changed from matter to anti-matter. Another example is my own experiment at Brookhaven National Laboratory, where we measured electron pairs. Physicists before us did experiments of the same kind. But we did a more precise experiment and found something new (the J/psi particle).

FLANAGAN: How is this different from previous experiments?

TING: There are several differences. The energy of LEP will be higher than any accelerator we have worked at before. The detector will be far more precise in its measurements of electrons, muons, and photons—a factor of 10 better than previous experiments. And from a sociological standpoint this experiment is also unique because of the many different countries, universities, and institutes that are represented.

FLANAGAN: In each phase of construction you have had different groups of people working simultaneously on different parts of the detector. Why? And

PHOTO: MIT NEWS OFFICE

how do these groups get along?

TING: Without many different groups we could not build this equipment in any reasonable time. L3 is the first large-scale international collaboration involving the People's Republic of China, the Soviet Union and the United States. The Soviets had no problems with the collaboration. Indeed, they put a high priority on the project, and their work has been excellent. On the other hand, I had great difficulty convincing the Chinese to participate; the P.R.C. had great hesitation about being involved with the Soviets. I had to go to see the [former] General Secretary of the Chinese Communist Party, Hu Yaobang and other high ranking Chinese officers, for permission for the Chinese scientists to participate.

All the participants are treated as equal partners; we leave all ideology out. Many Europeans in our group had strong feelings against the Soviets in the beginning. At CERN there have been some difficulties. The U.S. did not contribute to the construction of the new machine at CERN; it is a European laboratory and the U.S. is not a member country. Our L3 experiment is the only one to date that is led by an American. But we are coming to realize that we are all physicists together.

Like everyone else, physicists often have conflicts. People have different opinions. Normally, when there is a disagreement we have a meeting. Everyone has a say, even the most junior graduate students. After I have heard all the discussions, I make the final decision.

FLANAGAN: What significance do you think this experiment will have?

TING: We all hope, of course, that this detector will be the fulfillment of a dream to find the particles that bind our universe. But whether or not we reach that exciting goal, we expect to learn some new fundamental physics.

FLANAGAN: Would you prefer to do physics in the United States instead of at CERN?

History's Largest International Physics Collaboration

The next step in the world's progression to ever-more-powerful nuclear particle accelerators is being completed deep in the Jura Mountains near Geneva, Switzerland, at the European Organization for Nuclear Research (CERN). LEP, the Large Electron-Positron accelerator, will circulate electrons in a clock-wise direction and positrons (anti-matter) in the opposite direction through an underground tunnel 17 miles in circumference. Because they are traveling at very high speeds and in opposite directions, the electrons and positrons will collide with enormous energy—200 GeV (200 billion electron volts). The expectation is that new particles will be created and heretofore unobserved properties of matter revealed.

Four detectors will be located around the accelerator's ring to collect data on these high-energy interactions. Each detector is a major project for consortia of physicists throughout the world. The largest of the four detectors, known as L3, is assigned to a group headed by an American, Nobel Laureate Professor Samuel C.C. Ting of M.I.T. Construction of the 10,000-ton instrument is expected to cost about 200 million Swiss Francs (close to $135 million U.S.).

L3 is designed to detect and measure the energies of photons (massless neutral particles commonly known as light rays), electrons, and muons (particles that cannot be subdivided into other smaller particles) created by the vast energy release in LEP.

Ting's new project has given him the opportunity to unite physicists worldwide, making him something of a goodwill ambassador. At the outset he traveled to three continents to enlist leading physicists from the 40 institutes that are now participating in the construction of L3 and in experiments using the detector following its completion. Ting believes L3 is the first experiment to involve scientists from universities and institutes in the United States, the USSR, the People's Republic of China, East Germany, Taiwan, India, Bulgaria, and Western Europe. It may, he says, be history's largest international physics collaboration.

Organizing the L3 consortium was an enormous effort. The major tasks of design and construction were divided among several groups, with each responsible for one element of the detector. For example, Professor Ulrich J. Becker of M.I.T. leads a group from the Netherlands, Spain, Switzerland, Italy, and several American universities in designing and building a series of "drift chambers." The chambers are, in effect, microscopes of unprecedented size and accuracy that will detect muons with high precision. Charged particles pass through the gas in the chambers, leaving tracks which can be detected and recorded electronically.

A laser system as well as precision mechanics for the detector have been designed by the Charles Stark Draper Laboratory in Cambridge.

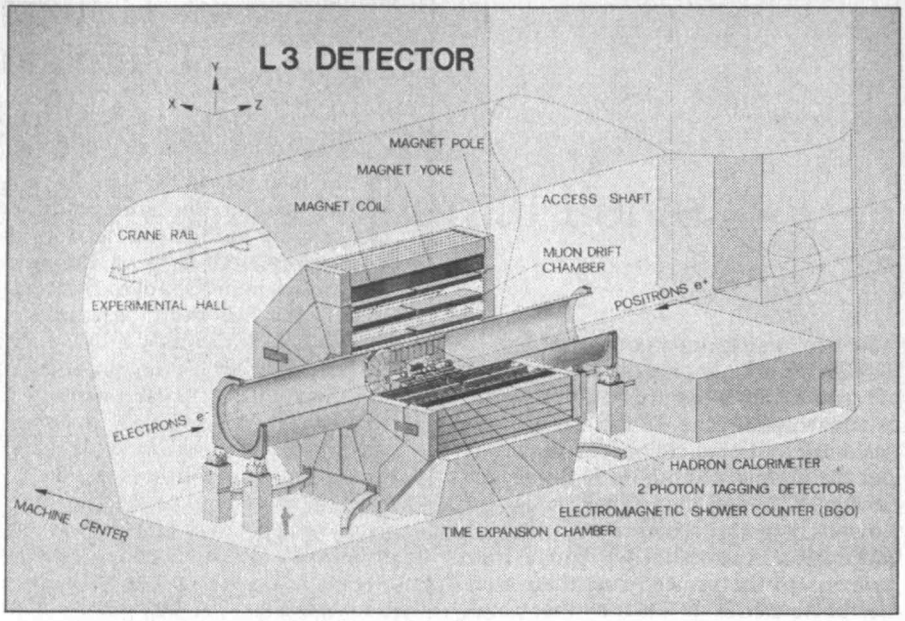
From Switzerland, the Democratic Republic of Germany, and West Germany will come the time expansion chamber at the center of the L3 detector; its purpose will be to measure the lifetime of the particles entering the detector by tracking them to their point of decay.

There are several other elements, but perhaps the most difficult negotiations are involved in designing and building the bismuth germanium oxide system that will make precision measurements of the amount of light created by electrons and protons produced by the high-energy LEP collisions.

First, germanium oxide of exceptional purity was provided by the Soviet Union. The germanium oxide is now being converted into 8,000 crystals by the Institute of Ceramics in Shanghai—the only place in the world where the crystals can be produced both economically and at a rate of 350 per month. France supplied forefront technology to the Chinese so that the crystals can be properly cut and polished. Precision electronics later attached to the crystals by physicists at Princeton University will convert light pulses produced by radiation passing through the crystals into electrical signals. Finally, the

Continued on page MIT 20

The tiny human figure sketched at lower left gives an idea of the scale of this massive detector that was designed at M.I.T. When installed along the ring of the world's largest particle accelerator, it will detect and measure the energies of particles created in high-energy collisions.



TING: Absolutely. It is too bad we have to go to Europe, but CERN has the largest accelerator. If the proposed Superconducting Supercollider (SSC) is built in the United States, we will certainly come back to America.

FLANAGAN: Is your being forced to use CERN a symptom of the United States falling behind in high-energy physics?

TING: Yes. It is most important for the U.S. to build the SSC. Recent publications show that Europe is somewhat ahead of the United States in numbers of papers reporting important developments in high-energy physics. Without SSC the United States cannot hope to match Europe. If you don't have the accelerator, you are out of the competition.

FLANAGAN: But isn't that a very large, very expensive project? Can we find new technology to produce smaller, more practical accelerators? They seem to be getting larger and larger.

TING: The SSC definitely has to be the limit. It will become part of the national budget. You clearly cannot go one step further. Unless there is a new development in accelerator technology, this field will come to an end. There are some hopes for lasers, but no one knows what will happen or what is the best route to take at this point.

FLANAGAN: Why is all this important—how does basic physics have a significant impact on society?

TING: The most important goal in this kind of research is to satisfy human curiosity. To understand basic particles is to understand where we come from. For example, 3,000 years ago people thought of earth, air, fire, and water as the basic elements; then we added sulfur and mercury, and by the end of the last century we thought that we were made out of electrons and protons. In the 1940s pi-mesons, mu-mesons, and elementary particles were discovered. By the 1960s we thought we were made out of 100 elementary particles. We changed our concept again when we found evidence for quarks. Through our discovery of the "J" particle we changed our concept again. We viewed ourselves not as 100 elementary particles but as a few quarks.

Our understanding of where we come from keeps changing. Our ultimate dream is to understand what are the forces that bind particles together.

In terms of practical applications, the most important example came at the turn of the century with the discovery of x-rays. We cannot know what applications the results of L3 may have in our daily lives. What we are doing now might completely change the concept of industrialization in the next century.

FLANAGAN: You have a reputation for being difficult to work for, yet people stay with you for years and are extremely loyal.

TING: Physics is very competitive. There is only number one; there is no number two. Whoever makes the discovery first gets the credit. The second person confirms the discovery. In the past, my colleagues and I have done precise and accurate experiments that have been widely discussed and rewarded. People comment about work mostly because they respect it. Fortunately, over the past 20 years, no one has negated the quality of our physics. We have often been able to do the best work ahead of other people. This is why people stay on as my collaborators, and why I'm in physics.

FLANAGAN: While they are working on these physics experiments, what do you try to teach your physics students?

TING: I try to teach two things. One is this: Whatever you do, do it carefully and do it correctly. When you write something down, make sure you understand what you are writing. Second is to always be suspicious about your own work. Very often experimental results, if you are not careful, will turn out to be wrong. People often remember your errors, not correct work. We check our work over and over to be sure it is correct.

FLANAGAN: If one of your daughters or your son wanted to pursue physics, what advice would you give?

TING: Physics must be the most important thing in your life. You must be willing to sacrifice almost everything. As I said before, physics is very competitive. And no matter how brilliant you are or how hard you work, the rewards are by no means guaranteed. Physics has something to do with luck. You certainly should not do it for glory or for fame. □

DIAGRAM: CERN

UNDER THE DOMES

University for Space Set for Launch in '88

The vision of nations and peoples united to study, explore, and exploit space brought a uniquely cosmopolitan forum to M.I.T. late last spring—the founding conference of the International Space University (ISU).

Author Arthur C. Clarke provided the keynote in his video address prepared for the meeting: "It takes very little effort to imagine that one day a space university will exist, with campus facilities located above the earth's atmosphere. For me, however, there is no better time than now to establish what would become a first, permanent human institution on the beachhead of space," said Clarke.

The idea is to provide a graduate-level educational opportunity for professionals from throughout the world who want to prepare for space-related careers or to become effective advocates of space development. In the words of Peter H. Diamandis, '83, and Kenneth H. Sunshine, chairman and vice-chairman, respectively, of ISU's Executive Board, "ISU will bring together outstanding professors and students from around the world to develop and disseminate a truly interdisciplinary space-related curriculum."

The first ISU classes will be at M.I.T. in the summer of 1988—an 11-week summer session with courses in such fields as space medicine, law, policy, and business as well as technical work in propulsion, structures, oribital astronomy, lunar exploration, and mission planning. Similar summer programs will be conducted by ISU at other institutions over the following four years. By then, say Diamandis and Sunshine, the project will have "generated sufficient course materials to consider adopting a full-year format."

Byron K. Lichtenberg, Sc.D.'79, president of Payload Systems, Inc., will be a major figure in planning these curricula as chairman of ISU's Academic Affairs Committee. And those who enroll in the progam—chosen on the basis of academic credentials and "propensity for leadership"—will earn academic credits at the host institutions that will be transferred to ISU when its full-time programs begin.

The list of those attending ISU's founding conference at M.I.T. was like a who's who of space; among them: Professors George Field and Martin Moore-Ede of Harvard, Philip Morrison and Laurence Young, '57, of M.I.T., and John Logsdon of George Washington University; Harrison H. Schmitt of the Planetary Society; Gerald K. O'Neill, president of the Space Studies Institute; W. Mac Evans, director general of the Space Policy Sector in the Canadian government; Cosmonaut Vladimir Dzhanibekov of the U.S.S.R.; Astronaut Robert Thirsk of Canada; U. R. Rao, chairman of the Indian Space Research Organization; Joseph N. Pelton, director of policy and planning for INTELSAT; and Zhili Li of the Ministry of Astronautics, People's Republic of China. □

Harbison Wins Pulitzer Prize

John Harbison, Class of 1949 Professor of Music, won the 1987 Pulitzer Prize for Music for "The Flight into Egypt," a Christmas choral work he composed for Boston's Cantata Singers.

In its retelling of the Biblical story, Harbison's composition addresses realities of urban life: the plight of the homeless and the slaughter of the innocents. It was first performed by the Cantata Singers in November, 1986.

David Hoose, who conducted the premier of "The Flight into Egypt," said that Harbison "set a very serious text with such directness of expression that it reached everybody who heard it."

Harbison is on leave this year as composer-in-residence with the Los Angeles Philharmonic. He was interviewed on the telephone by several journalists from Boston, where he is considered

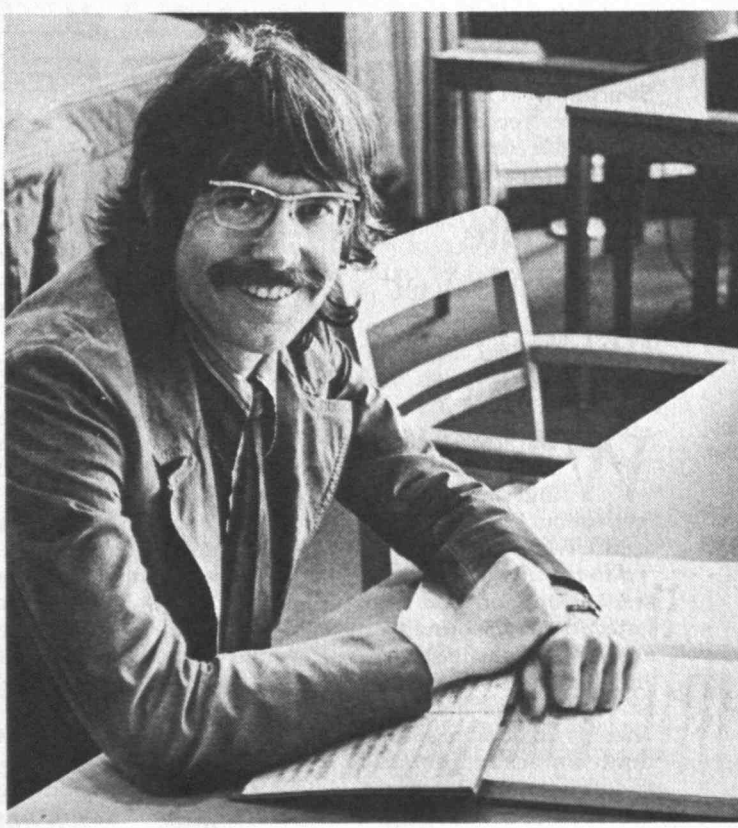


PHOTO: CALVIN CAMPBELL

a major force in the musical community.

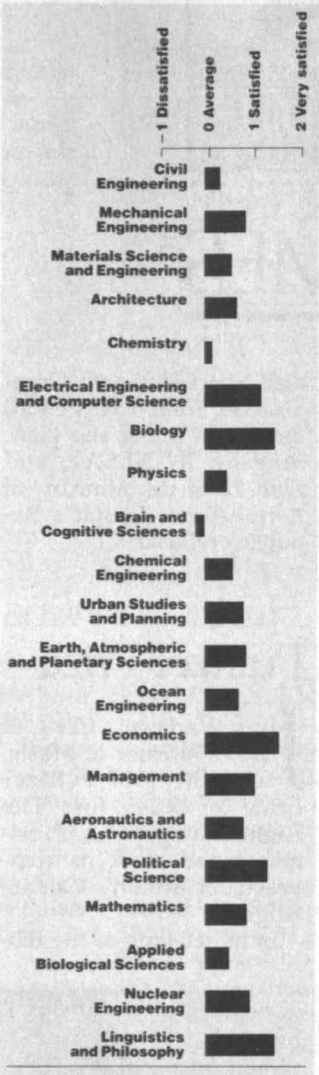
He was quoted as saying that he was surprised that a composition based on a sacred subject won, and said he was particularly pleased that this piece was recognized because of the statement it makes about the musical life of Boston. His own musical life is enriched by the amount of early music that is performed in Boston and by the community of musicians who "rehearse and perform sacred music of every era with tremendous energy and devotion."

A native of New Jersey and a Harvard graduate, the 48-year-old Harbison has been a member of the M.I.T. faculty since 1969. His Symphony No.1, written for the Centennial of the Boston Symphony Orchestra in 1981, was recorded by the BSO on the New World Records label. □

Graduate Students Vet M.I.T. Experience

What do graduate students think—and how do they feel—about life and learning at M.I.T.?

After a major survey of student opinion, the Graduate Student Council can answer: "Graduate students are, for the most part, satisfied with the Institute." There is "moderate satisfaction" on academic issues and "general indifference" on social issues, but significant dissatisfaction with graduate student housing.



On a scale from 2 ("very satisfied") to −2 ("very dissatisfied"), here is how M.I.T. graduate students rate the quality of teaching in each of the Institute's graduate courses. The data is from Graduate Student Council questionnaires completed by 1,600 graduate students in February 1986.

Just over 1,600 questionnaires distributed to graduate students on registration day in February 1986 were returned, a 40-percent response rate that GSC terms "excellent."

Norman M. Wereley, S.M.'87, president of GSC, says the project was successful in bringing "the facts [about graduate student feelings] out in the open." Frank Perkins, dean of the Graduate School, agrees. On subjects with which he's familiar, says Perkins, the results seem valid, and the whole process has been "a very positive exercise for the Graduate School," he says.

The single most important finding of the survey is dissatisfaction with graduate housing. Insufficient on-campus housing forces nearly 75 percent of all graduate students to live off-campus. In the Cambridge-Boston market, they are victims of a housing shortage that has pushed rents upward 5 percent faster than the rate of inflation every year since 1980 (when graduate student housing costs were last surveyed). According to the 1986 survey, single students living off-campus paid an average of $367 a month for housing, compared to $261 for single on-campus housing; married students averaged nearly $600 off-campus compared with $510 on-campus.

Furthermore, the housing crunch creates special problems for some of the very groups of graduate students M.I.T. wants most to enroll. While 60 percent of all graduate students said safety and security were major factors in their choice of housing, 81 percent of the women indicated concern for safety. Sixteen percent of the women students (compared with 10 percent of the men) have been victims of neighborhood crime as graduate students, and 15 percent of the women (10 percent of the men) have been victims of crime on or near the campus.

A large majority of students admitted that their decision to attend M.I.T. would not have changed had they known before coming what they now know about housing. However, more blacks and Hispanics than whites would have changed their minds, they said—a figure that GSC finds "particularly disturbing in light of the finding that 15 percent of black and Hispanic students felt they had not made the right choice in coming to M.I.T."

The result of these findings was to assure the goal of increased graduate student housing a higher place on the Institute's agenda (*see July* Technology Review, *page MIT 19*).

In general, student satisfaction with M.I.T. could be increased if students had more access to advisers, according to the survey. Less than half the students said they spent as much as one to three hours a week discussing their research with their advisers, and 5 percent said they spent only one hour per semester. S.M. students were less satisfied than Ph.D. students; black and Hispanic students were less satisfied than whites, women less satisfied than men. GSC concluded that "students generally wish to spend more time with their advisers."

Graduate students' views on academic quality varied widely between departments, and Perkins joins the GSC in thinking these variations are the most interesting and subtle products of the survey.

For example, on three crucial issues—satisfaction with research facilities, research guidance, and quality of teaching—the Departments of Biology; Earth, Atmospheric and Planetary Sciences; Electrical Engineering and Computer Science; and Nuclear Engineering received outstanding ratings. In addition,

CHART: OMNIGRAPHICS


R. A. O'Brien


W. J. Humann


R. B. Horton


R. M. Wagner


F. R. Meyer III


D. D. Wharton


E. R. Allen


F. Press


S. A. Jackson


J. McAfee


Y. Ayukawa


J. K. Castle

quality of teaching was judged high in Economics, Management, Political Science, and Linguistics and Philosophy. Chemistry and Physics were rated high on research facilities.

Departments that rated low in these categories have their work cut out for them, thinks Perkins, and many of them are busy with self-studies.

The Graduate Student Council, too, found a new challenge in the survey results. Graduate students reported "indifference" to the social environment at M.I.T., and GSC says that it must meet "a need for more social events directed specifically toward graduate students." □

Journalism Fellowships Continued

The fellowships to bring technology and science journalists to M.I.T. for one-year, mid-career educational experiences will continue on a long-term basis thanks to a $3 million grant from the Knight Foundation of Akron, Ohio.

In recognition of Knight's role as primary sponsor, the fellowships are now known as the Knight Science Journalism Fellowships. The name of Vannevar Bush, '16, originally given to the fellowship program when founded in 1983, will now be given to other M.I.T. activities in support of technology and science journalism, such as a planned series of short workshops for executives.

The Knight Foundation received its major endowment from the founders of what is now Knight-Ridder, Inc., owner of 34 daily newspapers and 8 television stations. Its grant replaces the earlier grants from the Sloan and Mellon Foundations that inaugurated the fellowships. The program will continue under the direction of Victor K. McElheny and is part of the M.I.T. Program in Science, Technology, and Society. □

12 Picked for Corporation

Eight men and four women, including ten alumni, were elected to the M.I.T. Corporation, effective July 1.

Six of those named are totally new to the Corporation, and six were either re-elected, elected again after an absence from the Corporation for a few years, or elected to a higher level of membership.

Elected life members:

□ Yaichi Ayukawa, '52, president, Techno-Venture Co. Ltd., Tokyo.

□ Jerry McAfee, Sc.D.'40, retired chairman and chief executive officer, Gulf Oil Corp., Pittsburgh, Pa.

Elected term members:

□ E. Rudge Allen, '48, executive vice-president and director, Fayez Sarofim & Co., Houston, Texas.

□ John Krob Castle, '63, president, chief executive officer, and director, Branford Castle, Inc., New York City.

□ Robert B. Horton, S.M.'71, chairman, chief executive officer, and director, Standard Oil Co., Cleveland, Ohio.

□ Walter J. Humann, '59, chairman of the Executive Committee, Hunt Consolidated, Inc., Dallas, Texas.

□ Shirley A. Jackson, '68, research physicist, AT&T Bell Laboratories, Murray Hill, N.J.

□ F. Richard Meyer III, '42, consultant in corporate mergers and acquisitions, Chicago.

□ Rita A. O'Brien, S.M.'77, director of financial assurance, New England Telephone Co., Boston.

□ Frank Press, president, National Academy of Sciences, Washington, D.C.

□ Dolores Duncan Wharton, president, Fund for Corporate Initiatives, Inc., New York City.

□ Robin M. Wagner, S.M.'86 (term begins October 1) graduate student in the Johns Hopkins School of Public Health.

Wharton was elected to a two-year term, the other members to five-year terms. Allen, Castle, and Humann were nominated by the Alumni Association, and Wagner was nominated by graduates of recent M.I.T. classes.

The *ex-officio* Corporation membership reserved for the president of the Alumni Association will be filled by Raymond S. Stata, '57, president of Analog Devices, Inc., Norwood, Mass. Stata was elected to the Corporation as a term member for five years in 1984. □

Killian Award to Forrester

The new laurel added late last spring to his many awards and honors outshines all others, Professor Jay W. Forrester, S.M.'45, told his faculty colleagues.

The reference was to M.I.T.'s James R. Killian, Jr., Faculty Achievement Award for 1987-88, given to Forrester by a faculty selection committee. The annual award recognizes "extraordinary professional accomplishments and service to the Institute." It carries a $5,000 honorarium, and the awardee is expected to deliver two lectures in the spring term of the award year.

Forrester was cited as "one of those rare individuals who possess not only the intellect and imagination to see the path ahead, but the skill and the stamina to



M.I.T.'s Women's Studies program has been enriched by the world view of geographer Joni Seager.

lead the journey. During his career of over 40 years at M.I.T., Jay has applied these talents across a remarkable spectrum of professional fields. In the process, he has left his mark on some of the most important technological achievements as well as critical national issues of our day."

Responding to the faculty citation, which listed a plethora of honors for his contributions to computer science and management, Forrester said the Killian Award is "a recognition I prize above any of those others."

During his first decade at M.I.T. Forrester worked on large-scale computer systems; he was the principal architect of a massive SAGE air defense system, and he devised a magnetic data-storage system that was crucial to digital computers before the development of semiconductor storage devices. In 1956 Forrester began a new stage of his career by applying his understanding of feedback control and computers to the analysis of managerial and social systems. Thus was born the field of system dynamics, offering counterintuitive insights for corporate and government management as well as for national and international social systems. □

Mapping Women's Lives

She describes herself as a feminist geographer, and in her new book *Women in the World: An International Atlas,* Joni Seager and her co-author Ann Olson do what geographers are expected to do. They map.

But these aren't the usual maps you find in a geography book. Seager and Olson are among the first geographers to map the plight of women around the world.

Their world atlas, published in the United States by Simon and Schuster late last year, explores the similarities and differences between and among women. "It raises fundamental questions about who has authority and power and who does not," say Seager and Olson in the book's introduction. The book's maps compare topics such as women and: marriage, motherhood, domestic violence, employment, education, government, the vote, ideology of beauty, rape, and the channels of change.

Seager is coordinator of the Women's Studies Program at M.I.T., and Olson is a cartographer at the U.S. Geological Survey in Reston, Va.

Interviewed in her office, Seager points out that women account for at least half the world's population. "We cannot simply look at the world of men and proceed to women as an afterthought.

"Women's lives are very different from men's lives, and they need to be analyzed differently. We are proposing that gender be used as a category of analysis in the same way that race and class are used.

"This atlas rests on the assumption that we cannot understand our world without understanding the everyday experience of women," in Seager's view. "As a geographer I look at the way cultures use space, particularly in urban areas. I have found that women experience urban environments quite differently than men because the environments—almost without exception—were designed by men.

"By mapping the world of women, patterns are revealed that are usually obscured in statistical tables or in narratives," she says. There is one particularly notable underlying pattern, says Seager: "In the world of women there are no developed nations.

"We were struck by the extent to which women are the second sex everywhere. They have a small share of the pie in every culture. Of course the size of the pie varies from country to country, but in no culture are women treated equally with men."

Seager and Olson also found that the feminization of poverty is a global phenomenon. "Women are in the majority of those defined as living in poverty in each country. . . . No society rewards women for doing women's work, and in some societies the penalties are very severe."

While uncovering these bleak statistics, Seager and Olson also uncovered some hopeful indicators. "Even in the places where women are most penalized, they are struggling for change," says Seager. Women are "coming out of the shadows and fighting for what is rightfully theirs.

"I define the beginning of feminism as acknowledging that women's lives and experiences are as important as men's lives and experiences," says Seager. She identifies the M.I.T. Women's Studies Program as "a challenge to the conventional way of thinking."

"We are asking that our society look at the root of how knowledge is constructed," said Ms. Seager. "All knowledge rests on a platform of assumptions, history, and prejudices. In Women's Studies we're saying, let's peel back that layer and examine and maybe change what's underneath. It is a simple concept, but one that is vociferously resisted."—*Paulette Boudreaux, M.I.T. News Office* □

PHOTO: DONNA COVENEY



ALUM· NEWS

A Head Start in Engineering Thanks to Hughes

When friends asked Wendy Power, '86, and Darius Sankey, '87, what they did last summer, there is a quick answer: they built communications satellites.

They and Lisa Lozo, '91, are beneficiaries of a scholarship program sponsored by Hughes Aircraft Co. to help women and minorities become engineers. The plan, in operation since 1972, is credited to Albert D. Wheelon, Ph.D.'52, executive vice-president who is now chairman-elect of Hughes.

Wheelon believes that business should do more than simply compete for the relatively small pool of minority and engineering female graduates. "We needed to work on the problem from the other end—to help fund education for those with the will but without the resources," he explained. So Hughes worked out a scholarship program that provides outstanding students with up to $2,100 a year toward the cost of their engineering studies, and summer jobs at $300 to $450 a week, working on high-technology electronics with teams of Hughes engineers.

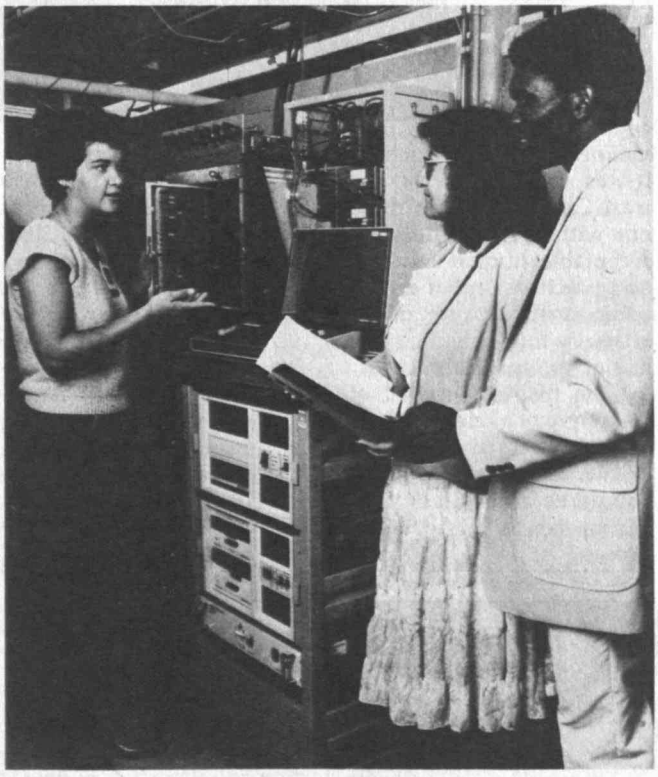
Sankey went to work at Hughes after his senior year in high school, and he's now a veteran of three summers there. During that time, he has helped develop computer programs that activate satellite communications systems, learned orbital mechanics, and worked on a proposal to use radar for mapping the surface of Venus. Sankey graduated this spring with a major in electrical engineering.

Power, with two summers at Hughes, is an aerospace engineering major who wants to "get into the control aspect of satellites and movement in space. Or I'd like to get into robotics," she says.

During her first summer at Hughes, Power helped engineers put together a prototype of a new brain for the Intelsat VI satellite, which provides commercial communications worldwide. Last summer she helped write the computer instructions for satellite motor control systems.

She's enthusiastic—"a good overall experience," Power says of her Hughes work. "Sometimes I was actually getting under the satellite shell with a screwdriver, other times I helped engineers with blueprints. Now I know what it's like in an actual work situation."

Sankey agrees. "Getting real work experience is important," he says. "Most engineering companies these days want to hire people with experience as well as with a bachelor's degree." □



The prototype circuit board that Wendy Power, '88, is holding will be part of communications satellite control system. Her audience is two summer colleagues at Hughes Aircraft Co., Los Angeles—Ruth Ramos and Darius Sankey, '87. Powers and Sankey received four-year Hughes-sponsored engineering scholarships, the brainchild of Albert Wheelan, Ph.D. '52. Ramos, the daughter of a Mexican immigrant, also held such a scholarship; she has been working at Hughes since earning an engineering degree in 1984.

Fundraising Award

The first recipients of a new Henry B. Kane, '24, Award will be announced at the National Alumni Conference in Cambridge next October 23 and 24. They will be honored for "exceptional service and accomplishments in fundraising for the Institute and/or its Alumni Association."

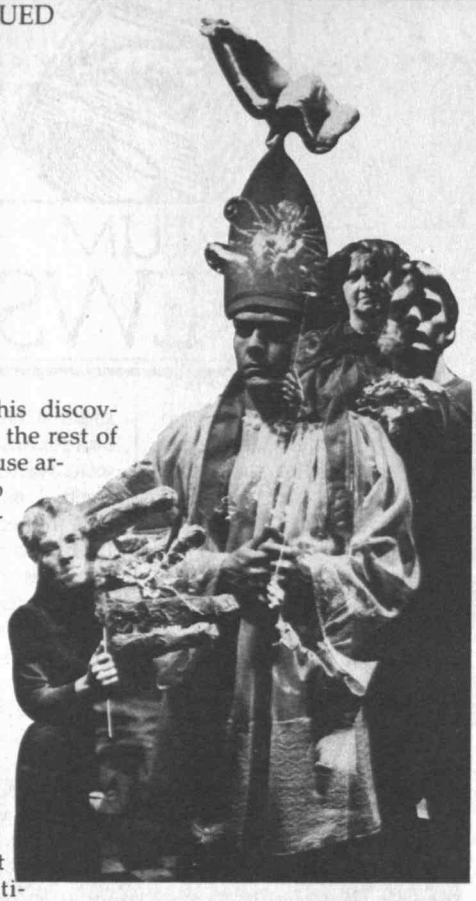
The award, to be given by the Board of Directors of the Alumni Association, honors the first director of the Alumni Fund. Returning to the Institute in 1940 at the invitation of then-President Karl T. Compton to organize an alumni fund effort, Kane served as director of the fund until his retirement in 1966. □

Club Report

The M.I.T. Alumni of Colorado found a cultural event that was particularly riveting for veterans of an education based on mathematics and science: a late winter production of Bertolt Brecht's play "Galileo." The play focused the attention of some 55 alumni and guests on the conflict between the free inquiry of science and the orthodoxy of organized religion.

The personality of Galileo dominates the play. As imagined by Brecht, Galileo is an isolated genius, a man ahead of his time. His work with the telescope leads him to the conviction that the earth is but an insignificant member of a vast universe, and prompts him to debunk the notion of a heaven just above a fixed dome of stars. He is thrown into direct opposition to the strongest social force of his time—the Church.

Threatened with torture, Galileo recants his discoveries. He spends the rest of his life under house arrest but is able to produce important work on the theory of mechanics.



Intermission and post-performance discussions were an important part of the evening, according to event-organizer J. A. Baring, '48, at least in part because of the timeliness of the production. It was shortly after the Roman Catholic Church came out with a report defining acceptable human fertilization practices and at a time when textbooks are under attack by fundamentalist religious groups in the U.S.

"The play's portrayal of the agony of a scientist compelled to deny what he knows to be true . . . personalizes a conflict" that Baring sees as very contemporary. "Were similar conflicts lived out by members of the flight-approval technical teams before the Challenger disaster?" Baring asks in a report on the event.

The M.I.T. group made up close to half the audience for one performance at Denver's Germinal Stage. And a final note: For and evening of theater that opened with a wine and cheese reception, Colorado alumni paid only $15 per person. □

International Team Builds Accelerator

Continued from page 13

French team is also responsible for testing and calibrating the crystals after they are shipped to CERN.

Each institution in the consortium provides people, money, and materials. From the U.S.S.R. is coming also 7,000 tons of low carbon steel, more steel than was used for the Eiffel Tower. Approximately 1,100 person-years of work by engineers, technicians, and machinists are coming from participating European and Indian institutes. The Swiss have contributed 1,000 tons of aluminum, and the United States has provided funding for the work of all the U.S. universities through the U.S. Department of Energy and the National Science Foundation.—*J.P.F.* □



The 1987 Florida Festival drew some 75 alumni, spouses, and friends to a day-long symposium on Project Daedalus, the M.I.T.-Smithsonian Institution collaboration in human-powered flight. (Left to right): Peter Hand, '48, regional chairman of the Educational Council in Orlando; guest speaker Steven Bussolari, Ph.D.'83, assistant professor of aeronautics and astronautics and the director of flight operations for Project Daedalus; Elda Chisholm, '49, president of the M.I.T. Club of Palm Beach County; and Louis Alexander, Alumni Association regional director for the Gulf/Atlantic region and an organizer of the event. Associate Dean of Engineering and principal investigator for Project Daedalus Jack Kerrebrock, along with pilot Lois McCallin, also traveled to Florida with Bussolari. They all discussed the physical and technical challenges of pedaling their delicate aircraft from Crete to Greece later this year.

PHOTOS: GERMINAL AGE; UNIVERSAL CONVENTION PHOTOGRAPHY



CLASS NOTES

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I talked with **Francis Hann**, who was bright and cheerful. He announced he has a 95th birthday coming up on Pearl Harbor Day (December 7). He says he does not travel anymore but still gets out and around every day to the post office and so forth. Recently received a note from him which was much appreciated more than words can express!

Mimi Plummer Rice fell last July, laid on the floor until morning, developed pneumonia, and had another stay in the hospital. But now she is needlepointing and knitting, which keep her happy. She is the oldest in a retirement home of 104 residents. One of her daughters is the wife of the captain of a big missionary ship in South Africa, and she returns every six months to visit Mimi. Her other children live in New Jersey and Puerto Rico and phone her often.

Robert Coldwell, son of **Everett S. "Jerry" Coldwell**, writes to say his father passed away at the Wartburg Home in Mt. Vernon, N.Y. He was 93. Robert says M.I.T. was close to his father's heart. He and his brother William heard about it almost as infants.

Jerry much enjoyed the classnotes in the *Review*, particularly **Loring Hall**'s diary. Robert also notes that one of my letters to Jerry brought back memories to him, as he learned to fly in the mid-fifties while working for Westinghouse in Cheektowaga.

More of **Loring Hall**'s diary:

March 9, 1915: Sent in an application for a job with the Standard Oil Co. foreign service. I may not want it, but it will be an "anchor to windward" if I don't land something else. Engineering openings are not too plentiful this year. Took Kay to dinner at the Lombardy Inn where we had an excellent planked steak with all the fixings. It was expensive, $2.75 plus 30 cents tip, but worth it on her birthday. Then went to the auto show for the evening—lots of fine new models.

March 10, 1915: A meeting of the 1915 Printing Committee. We elected **Guernsey Palmer** chairman. Discussed all the paper work that will be necessary for graduation activities.

March 13, 1915 (Saturday): Had an especially interesting lecture this a.m. by Professor Breed. He has just been elected president of the New England Railroad Club. He is a fine man. Worked on my railroad design until 4:30, then **Joe Livermore** asked me to go for a ride in his new Ford. **Arthur Stubbs** and **Howard Thomas** went too. After supper, worked until 12:30 a.m. on my railroad problem for Tuesday.

March 15, 1915: Another meeting of the Course I Smoker Committee. Ate lunch with **Howard Thomas** and **Charles Ward** at the Union. Had a good mackerel lunch, 15 cents. Then Howard and I visited several hotels to get prices for our final dinner of the C.E. Society. The Copley Square offered us an excellent menu for $1.50.

March 17, 1915: Attended the structures and railroads classes. At 4:30, there was a meeting of the Class Day Committee. I was elected chairman of the Budget Committee, which means more outside work. Time is getting pretty tight.

March 19, 1915: **Jim Tobey** and I went "stag" to the show given in Huntington Hall by the student body to aid M.I.T. Athletics. It was called "Nismand Zu House." It was funny and a financial success.

March 20, 1915: After classes went to the South Station and made a study of the trains to see which ones used sand when they started up and how many slipped their driving wheels. The results were varied and very interesting. Should make good material for a professional paper.

March 22, 1915: Went to see Dean Burton about buying some books for the M.I.T. Summer Camp out of the surplus in the C.E. Society treasury. After classes we had a meeting of the Printing Committee at the Union. A man from Wright's Philadelphia engraving house showed us a barrel of Class Day programs. It will be hard to decide. Went with **Seward Highley** to Boston Bridge Works. While we were waiting for Mr. Moses, I noticed some blood on my coat and found it was coming in a stream from Seward's neck. Rushed him to E. Cambridge Relief Station, where a doctor stopped the flow. He said it was from a burst artery. Alarming, but not dangerous if caught promptly. Next, had a meeting of the Budget Committee.

Well, classmates, guess it is time to sign off and continue in the next issue. Meanwhile, my best to all of you, and thanks so much for participating in the M.I.T. 1987 Alumni Fund, and especially for your contacts with me!— **Joyce E. Brado**, Acting Secretary, 491 Davison Rd., Apt. 9, Lockport, NY 14094

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Your secretary is happy to report that he participated in the spring meeting of the Cardinal and Gray Society at Endicott House in Dedham, Mass., on May 3, 1987. It was an opportune time to enjoy renewing friendships with about 75 graduates including wives. The speaker of the day was Professor Irwin Sizer, president of the Whitaker Health Science Fund, former Dean of the M.I.T. Graduate School, and former chairman of the M.I.T. Department of Biology. He delivered a most interesting lecture of new developments with the DNA molecule—particularly in creating new medicines for overcoming diseases. Classmates will recall that the Cardinal and Gray Society is a development of our annual class reunions at Endicott House.

Herb Larner sent me a copy of a most interesting letter he sent to the *New York Times* regarding race relations.

Your secretary records with sorrow the passing of Dorothy Berman, who participated in many class activities with Eli since graduation. I was most impressed with her many activities as described by the rabbi at the funeral service.—**Max Seltzer**, Secretary, 865 Central Avenue, Needham, MA 02192; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146


97-year-old WWI flier to lead Westhampton Memorial Day march

Attired in his French beret and medal-decorated coat, Walter Muther, '13, rode in his neighbor's Model A Ford at the head of the Memorial Day parade in Westhampton, Mass., last May. Providing support for the 26th Yankee Division in northern France, the World War I flier recalls two near mishaps—once when his plane was hit by Germans (and he barely made it safely over American lines) and another time when his plane almost ran out of gas in enemy territory. "We didn't have parachutes, and the planes didn't have brakes," says Muther. Muther attends M.I.T. Alumni Council meetings and his class reunions regularly, being the oldest alumnus present at this year's Technology Day.

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We regret to report to you the death of a well-known classmate, **Benjamin H. Bristol** , of 28 Union St., Foxboro, Mass., on January 28, 1987, at age 90. His bachelor's degree was in mechanical engineering, and in 1975 he received an hon-

orary doctorate from Clarkson University. He was president of the Foxboro Co. (founded by his father) until his retirement in 1966, when he became chairman emeritus of the board. He is survived by two sons, Edgar H. and William L., both of Foxboro; a daughter, Eleanor B. Woodason of Foxboro; a sister, Justine Perry of Amherst; and nine grandchildren.

Ben Bristol, as we called him, was a good friend of our class and of the Institute, both of which he served on many occasions. He was scheduled to attend our last reunion but was unable to, although we did speak with him by phone. We shall miss him and are happy we were once together.

Do keep well and remember we are hungry for class news.—**W. O. Langille,** Secretary, Box 144, Gadstone, NJ 07934, (201) 234-0690

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Phil Rust of Thomasville, Ga, died last October 8. He is survived by his widow, Eleanor, four sons, and seven grandchildren. He was associated with Laird & Co. of Wilmington. He was an accomplished flutist, operated a tree farm near Pensacola, Fla., and was a cattle breeder. . . . **Bob Miller** of Rumson, N.J., died January 20. He is survived by his daughter, Betty.

A recent visit from **Al Burke** contained the sad news that his wife, Betty, had passed away last November. She was a classmate of my own dear wife at the New England Conservatory.—**Harold Bugbee,** Secretary, Apt. 313, Country Club Heights, Woburn, MA 01801

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Well, here it is early May and I'm writing notes for the late summer. I don't have much news. When I was assistant secretary prior to 1971, I used to supply **Carole Clarke** with a lot of news, but I practically never hear from him or **Sam Lunden.** So what should I do? I want news.

I did get my annual letter from Captain **Elliott Roberts** living in Carl Vinson Hall, Mclean, Va. He says that he and his wife Becky are doing well and enjoy living in the large establishment built and operated for retired military people. "We have a chapel, a hobby shop, scheduled musical events, movies, and other entertainment. My only lack is the absence of any chess players." Elliott still drives and gets in to the Cosmos Club in Washington from time to time.

News on an Alumni Fund envelope from **Kenneth Bates** of Canton, N.Y.: "I am fine and getting along very well. Lots of children, grandchildren, and great-grandchildren. I visit my daughter in Fort Collins, Colo., twice a year. Still drive my car."

There was one death notices this month—that of **Harry M. Witherow** of Schenectady, N.Y., on January 11, 1987. Harry was a retired electrical engineer from the General Electric Co. He served in the army's 317th infantry during World War I and received a certificate for distinguished and exceptional gallantry.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 12203; **Samuel E. Lunden,** Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

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These notes are written in May. Comments about our 65th will be in the October *Review*. A pleasant note from **Ed "Doc" O'Connor** tells of his seeing **Ed Keene** now and then. Ed, recently retired from Fay, Spofford & Thorndike, is in fine shape. "Doc" is easing up but continues at golf still shooting his age or close to it. He is kind of busy at birthday celebrations with 13 grandchildren and two great-grandchildren.

Arthur Bell Craig, age 86, died at his home in Santa Monica, Calif., after a long illness. He entered M.I.T. as a sophomore after preparing at Marion Military Institute and Georgia Tech. His studies in the cooperative course in electrical engineering resulted in his employment by the Boston Edison Co. where in due course he became chief electrical engineer, retiring in 1965. He continued to live in Wollaston, Mass., for many years before moving to Mercer Island, Wash., and then to California. He is survived by his wife Marion; a daughter, Marylyn Lightfoot of Mercer Island, Wash.; two sons, Dr. Arthur Craig of Spokane, Wash., and Glen Craig of Santa Monica, Calif., 11 grandchildren and two great-grandchildren. The sympathy of the class is extended to the Craig family.—**Yardley Chittick,** Secretary, Rte. 1, Box 390, Ossipee, NH 03864

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Howard Lockhart has a new address: 180 Water St., Mission Towers, Haverhill, MA 01830. . . . **Bill Allis** has written an open letter to President Reagan claiming that SDI is unfeasible and impractical.

Everett Brown died December 1, 1986. He graduated with our class in electrical engineering. For many years he was vice-president and electrical sales engineer with Cheatham Electrical Switching Device Co. in Louisville, Ky. He enjoyed swimming and photography. . . . **Theodore Carpenter** died on December 17, 1986. He graduated with our class in electrical engineering. He was staff engineer for Altec Service Corp., a subsidiary of LTV, Inc., for over 40 years, retiring in 1969. During World War II at Columbia University and at Groton, Conn., he developed the Sono-buoy, an anti-submarine device successfully used during the war. . . . **Earl Griswold** died on December 13, 1986. He received his S.B. in biology and public health at the Institute. He was awarded an honorary doctor of laws degree at American International College in Springfield, Mass., in 1970. He returned to the Institute in 1928 to become a research associate in the Biology Department. In 1931 he became director of manufacturing for Zonite Products Co., in New York City. He then moved to Tampax, Inc., Lake Success, N.Y. to become assistant to the vice-president, director of manufacturing, executive vice-president, and consultant to the firm, retiring in 1968. During World War II, he was a member of the Rationing Board, Brimfield, Mass. He was a devotee of alumni affairs, a member of the M.I.T. Development Committee, and reunion committees. He was also very active in numerous civic and social organizations.

Alexander Newman died September 8, 1986. He first attended Cooper Institute, then graduated with our class in electrical engineering. After graduation he was employed by Stamford Gas and Electric Co. as assistant to the General Manager. In 1926 he became foreman in Meter Bureau of United Electric Light and Power Co. In 1928 he worked for New York and Queens Electric Light and Power Co. as general foreman in the Meter Bureau and then as an engineer in the Electrical Engineering Department until his retirement in 1964. He was the author of numerous publications appearing in *Electrical World Magazine*. He played the violin, but his major hobby was photography with emphasis on closeups of flowers, insects, crystals, and refractions.

Jason Bickford died November 12, 1986. He attended Norwich University before entering the Institute. During World War I he served in the U.S. Army. For many years he served as manager, treasurer, and director of the former Tolls-Bickford Lumber Co. and of the Tolls-Bickford Realty Co., Inc., in Nashua. He served also as the president of the New Hampshire Retail Lumber Dealers' Association and was a director of the Northeastern Retail Lumber Dealers' Association and a director of the Cooperative Reserve Supply of Cambridge, Mass. He was a former director of the Indian Head National Bank and was presently serving as a director of the Nashua Federal Savings and Loan Association, of which he was a former chairman of the board. Mr. Bickford was active in a number of other professional and civic organizations.

Calvin Bolster died December 3, 1986. He graduated from the U.S. Naval Academy in 1920, and returned to Annapolis for the course in naval architecture at the Naval Post-Graduate School. He continued such instruction at the Boston Navy Yard and at the Institute and received his M.S. degree in Naval Architecture in 1923. After a brief tour of duty, he went to California Institute of Technology for advanced research in aerodynamics and received an M.S. degree in aerodynamics in 1936. He helped develop the jet-assisted take-off system for planes on aircraft carriers. He was a staunch supporter of Robert H. Goddard, considered the father of modern rocketeers. Early in his career he supervised the construction of the *Shenandoah*, one of the navy's first dirigibles. Qualified as a dirigible pilot, he was assigned to the airship *Macon* which crashed in 1935. He later qualified as an airplane pilot and was assigned to the carrier *Ranger* as assistant air officer. During World War II, he was in charge of the ships and installations branch in the engineering division in the old Naval Bureau of Aeronautics. After the war, he was assigned in San Diego and then to Washington as assistant chief of the new Office of Naval Research. He was made rear admiral in 1943 and retired as chief of the Research Office in 1954. He then became director of research for the General Tire and Rubber Co. in Akron, a post he resigned in 1962 to become director of long-range planning for Aerojet General Corp. in El Monte, Calif. He retired a second time in 1967.

He received the Legion of Merit award for his work in development of the jet-assisted takeoff system and in supervising the navy's anti-submarine warfare and air-to-air guided missle programs. His other honors include the Goddard medal of rocket research in 1949 and the National Air Council award in 1950. He was a member of the American Institute of Aeronautics and Astronautics and was an honorary member of the Order of the British Empire.—**Richard H. Frazier,** Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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Richard T. Lassiter, our efficient and hard-working class agent passed away February 28, 1987, in Cleveland, Ohio. Dick was awarded an S.B. in civil engineering, hydro-electric option. As all "civils" in our time, he attended Camp Technology, Machias, Maine. His picture can be found in a close-up on the lead page of the *Benchmark 1922* under a campaign hat, puffing his corncob pipe. At M.I.T., Dick was a three-year member of the Civil Engineering Society, the Society of Miltary Engineers and Phi Mu Delta.

We have a letter from Betty Hoyt, daughter of **George M. Tapley,** informing us that George died April 16, 1987, in Delray Beach, Fla. The victim of cancer, but up and about three days previous to his death, still fighting to improve, George died painlessly. He earned his S.B. in civil engineering, hydro-electric option. As all of us, he spent a summer at Camp Technology. He was that rare individual who studied, then widely applied his knowledge all his life, designing and constructing dams and hydro-electric plants in the eastern United States, Burma, Lebanon, and El Salvador. As a senior engineer in the U.S. Army Civil Works Program, he participated in numerous flood-control projects and was commissioned a major in the Corps of Engineers on the Alcan Highway project, which gained him appointment as chief design engineer of the Alaska Road Commission.

Upon retirement in 1966, he became City Engineer for Haverhill Mass., until 1971, when he took up residence in Delray Beach, Fla. He was a

registered professional engineer in New York and Massachusetts and awarded the Army's Decoration for Meritorious Civilian Service for superior work in the North Atlantic Division, Corps of Engineers.

By the time you read this, **Ray Lehrer** and **Dick Shea** will have abandoned their Florida haciendas for New England's refreshing cold summer.—**Russ Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146

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The final meeting of the Alumni Council for the 1986-87 season on April 27 found the class represented by **Courtenay Worthington** and your secretary. Our honorary classmate **Joe Martori** presided at the meeting and reported on the Alumni Fund. By the time you read these notes, Courtenay will have spent several weeks in Spain visiting with his son.

More information regarding **Ed McLaughlin**'s passing has reached your secretary. Ed, over the past several years, has been a regular attendant at Alumni Council meetings. It was at the November 24, 1986, meeting that he suffered an attack and was transported to the Mt. Auburn Hospital in Cambridge. He was confined there for about ten weeks and died on February 3, 1987. Ed is survived by a cousin, Raymond McKinnon of Wilmington, Mass.

It is with sorrow that the passing of three classmates must be reported. Colonel **John C. Dunbar** died on June 1, 1986, in Kendall, Fla., suffering cardiac arrest. He is survived by his wife Helen. . . . **Edward W. Eager** passed away on June 28, 1986, in Newark, Dela. Ed worked in merchandising and marketing for 35 years with Sears, Roebuck, and Co. He was an army major during World War II serving in France and in the Battle of the Bulge. He is survived by his wife, Elizabeth M.; a brother, Robert, of Hingham, Mass.; and a sister, Margaret Thompson, of Hyannisport, Mass.

Dr. **Harold Washburn** died in Long Beach, Calif., on November 25, 1986. Harold was a professor emeritus of the California State University of Long Beach, School of Engineering. He is survived by his wife Sigrid, two sons, Stephen and David, and a sister, Gladys Fisher.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Road, P.O. Box 331, North Chatham, MA 02650

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Our 60th reunion was a success with our classmates already talking about our 65th reunion. We had 45 classmates and 30 wives coming from as far away as Col. **Arthur Fuller** from San Diego and **Shantann Kirleskar** from Punna, India. We almost had **Chris-Yank Shih** from Peking, China.

At the Friday luncheon, we found out what the class of 1926 had done the last five years (with help from Mark Greer and Austin Kelly). It was announced that our class donated over $2 million dollars.

At our Friday night dinner, we were honored by David S. Saxon, '41, chairman of the M.I.T. Corporation and his wife, Shirley. Formerly, he was president of the University of California. **Bird Kelly** told us a lot about the circus, and **Arthur Johnson** about the sad death of a mule. **Ben Margolin** played a tape of a cassette that **Dick Whiting** had made of the Tunesters, who played for dancing so the rest of the musical clubs could form a stag line.

On Saturday, we had a historical bus ride through Cambridge, Lexington, and Concord, including visits to historical exhibits and parks. After an excellent lunch at the Concord Inn, we had an extensive tour of Boston.

At our Saturday night dinner, **Jim Killian** spoke about his very interesting experiences as president and chairman of the board of M.I.T. and President Eisenhower's scientific advisor. I have bought Jim's book, *The Education of a College President* and have read parts of it, finding it very interesting, and am looking forward to reading all of it this fall after I have my cataracts removed.

Earl McMahan told about heading a large group who got the Coast Guard to let them fix up the "Old Bug Light" in Plymouth Harbor and keep it from being torn down and being replaced by a pipe in the sky. The Coast Guard was ready to spend $400,000. His committee raised money and saved the lighthouse for $25,000 of private money. **Ben Margolin** played a video of our 50th reunion, showing **Dave Shepard**, **George Warren Smith**, and the banjo duet of **Dave** and **Ray Mancha**. You remember that our 55th was our last chance to see and hear them.

We missed having **Bill Meehan**, as he had a cataract removed that week with treatments preceding on his glaucoma. **Pink Salmon** had expected to be with us, but a cancer operation on his wife, Mary, interfered.

The same four officers as listed on our letterhead have been reelected. We want to thank Louis Alexander of the M.I.T. staff who was with us from start to finish and kept everything running smoothly. In the next issue I'll include information regarding classmates' activities.—**Donald S. Cunningham**, Secretary, 27 Lowell St., Braintree, MA 02184

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We are pleased to have a few more classmate histories: **F. Dallas Sparre** of Wilmington, Del., was a chemical engineer with DuPont for 43 years and retired in 1971. His work has seen a wide scope in five DuPont plants. He has served as research engineer, production foreman, area supervisor, technical superintendent, and regulatory consultant. He lists his accomplishments as (1) "writing the book on labeling hazardous chemicals" and (2) "collecting paychecks for 43 years." Dal did consulting work for a major chemical association from 1971 to 1975, dealing in labeling and product regulation. Since then—just as little as possible! He suffered a dislocated shoulder in 1981 which has never completely healed and has had to give up sports. . . . **John W. Norris** of Marshalltown, Iowa, started with Lennox Industries, becoming assistant sales manager, vice-president, and finally president and chief executive officer of the company. During his presidency in 1968, his company won the "Best Engineering of a Consumer Product" award for their quiet heat exchanger. Now retired in his home town, John is busy with non-profit groups—hospital, school and retirement center. He took charge of a $7 million rebuilding program for the Community Hospital. He enjoys his home workshop as a hobby.

Russell R. Smith of Avon, Conn., was a Course VI-A graduate who pursued his electrical engineering career with many major companies: Pennsylvania Railroad—electric locomotives, multiple unit car sub-stations, general plants, and terminal facilities; Glenn L. Martin Co.—assistant electric design engineer for military and commercial aircraft electrical systems; Westinghouse New Products Engineering Department—senior development engineer for advanced aircraft systems (made 11 patent disclosures and received several company awards); Westinghouse Aircraft Gas Turbine Division—aircraft jet engine electric controls; General Electric Defense Systems Department in Syracuse and Missile and Space Vehicle Department in Philadelphia; U.A.C. Corp. Systems Center in Farmington, Conn.—senior engineer, worked on electric power supply for Apollo Lunar Module landing sensor control and high-speed train electric systems. Since retirement, Rus has been busy with numerous groups in his home town, such as the Commission for the Bicentennial. He enjoys his activity as assistant to his landscape director (wife Cathy) on their one-and-a-half-acre home. . . . **Charles W. Dinan** of Nutley, N.J., is a chemical engineer who spent most of his working years at Koppers Co. of Pittsburgh. He retired in 1971 as assistant manager and now enjoys every minute of his leisure. He and his wife Alice enjoy travel and bridge.

Harland P. Sisk of Yarmouthport, Mass., writes of his active life on Cape Cod. He retired from General Electric-Pittsfield, in 1967 as general manager. He moved to the Cape and was business manager for the School Department of Dennis and Yarmouth. He became SCORE chapter chairman. He organized a course on business management at Cape Cod Community College. He has been treasurer of Cape Times Needy Fund for 13 years and is a member of Cape Cod Art Association. . . . An accomplishment which many of us have considered but never attempted is to write and print an autobiography. Just such a book was written by **Col. Charles C. Smith**, who died in Green Valley, Ariz., January 6, 1980. A detailed account of his forebears and his family, his various homes, and particularly his distinguished career with the army, the book is sprinkled with old photos and significant appendices. Much credit is due to his second wife, Eleanor. He finished writing a few weeks before his death. The story portrays a fascinating and colorful life.

B. Joseph Eiseman, Jr., died on June 29, 1986, in Memphis, Tenn. We regret the delay, but his niece notified us after receiving our reunion notices. He was a graduate student in Course V, and she says he was "something of a recluse." . . . **John L. Locke** died on December 22, 1986, in Norwood, Mass. He had been employed for 43 years as an assistant superintendant in the box division of the Bird and Son Co. in Norwood before retiring in 1967. At one time John was chairman of the American Cancer Fund drive. He suffered many years from cancer; he was 84, reports his widow, Louise. . . . **E. Stanley Bogert** died on February 16, 1987, in Holmes Beach, Fla. We have no information about him except that in 1967 he was a partner with A.S. Becker Decalsomania in Ridgewood, N.J. . . . **Parke A. Hodges** died on February 16, 1987 in Cambridge, Md. He was a mining engineer and consultant of the first order. He retired in December 1972 at age 70 from the job of president and treasurer of Behre Dolbear and Co., mining, geological and metallurgical consultants, a firm with which he had been associated for 23 years. He was a frequent world traveler to remote countries in his business.—**Joseph C. Burley**, Secretary, R.F.D. #3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Assistant Secretary, 2150 Webster St., Palo Alto, CA 04301

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We were very glad to have a letter from **Charlie Southwick** but saddened by its contained news of **Phil Taylor**'s death (reported separately below). Concerning himself, Charlie says, "Margaret and I have finally sold our historic property in Hope, New Jersey and it is being converted into a country inn. We will be here in the summer for a few years living in one of the houses. Meanwhile we spend the winter in Hilton Head, S.C., enjoy traveling (especially Alaskan cruise plus a week with son in California). Margaret does genealogy and I am a woodworker. Our three sons are scattered around the country as are our four grandchildren." **Jim Donovan** received an interesting letter from **Noel Olmstead** in El Paso, Texas. In 1979 Jim had written to Noel suggesting that he (Noel) look up **Walter Nock** who was also living in El Paso at that time. Walter has since died (1983). Now for the rest of the story we quote from Noel's recent letter: "Dear Jim, a few days ago while cleaning out some old files I came across the attached letter from you. At that time I was very involved with my wife who was afflicted with Alzheimers. As I had not known Walter at Tech I filed the letter and forgot it. This time, though, I was really startled for **Lela Nock** lives in the apartment just above us in this retirement village. When I showed her the letter she



Maggie and John Scheuren, '30, (left), along with their chaplain/co-pilot, flew a four-place aircraft from the local flying club during their recent trip to Sondrestrom, Greenland. He may be the only member of our class who still flies a plane, says Gordon Lister, class of '30 secretary.

let out a 'WHEEeeeee, this is just like discovering a relative!' " Yup, '28 is a family!

As for the Donovans, Jim is doing well and Frannie is nearly recovered from the fracture caused by her recent fall. A news bulletin from the Brigham and Women's Hospital Auxiliary (Boston, Mass.) gave a very impressive account of Frannie's life contributions in professional, civic and volunteer work. We can well be proud of her as our associate '28er!

Ed Walton called Jim and Frannie by telephone early in May from his home in Scarborough, New York. He has recently purchased a home in Honolulu so as to be near his sister. **Paul Johnson** lives in Honolulu on the same street with Ed but they have not yet had contact. Ed has lost much of his eyesight but he is planning to attend the 60th '28 reunion next year. Lastly and importantly, we congratulate Ed on his recently becoming an M.I.T. Sustaining Fellow.

As always, we are delighted to correspond with our class widows. Jo Shiepe, widow of **Edward M. Shiepe**, sent a vacation postcard from Ft. Lauderdale, Fla. just to say she was enjoying the Florida sunshine. . . . Helen Murphy, widow of **Robert E. Murphy**, wrote a very nice letter wherein it is obvious that her spirit continues to be as strong as always. However, she is hampered by failing eyesight and must now be content with reliving the many reunions of the past that she enjoyed with Bob. . . . We have been in touch with Bettie Day, widow of **Chester M. Day**, by telephone and have received a lovely note from her. Stephen, Chet, and Bettie's grandson, will graduate this year from M.I.T. following successively (and successfully) in the footsteps of both Chet, Jr. and our own Chet.

At this time we must report with deep regret the deaths of four classmates. **Dean E. Batchelder** died February 16, 1987, eight days after being struck by a van in his own driveway. Notes came from his wife, Ellen, and his daughter Gay. Dean graduated in Course VI, electrical engineering, but much of his professional work was in oil well service and geophysics. In 1974 he retired to his own ranch home in Hot Springs, Calif. He and Ellen were with us at the 55th Reunion and they had been looking forward to the 60th.

Max Bearon died May 8, 1987, after a long illness. Max was a graduate from Course XV, business and engineering administration. He was with Stone and Webster early in his career and served as a U.S. Army major in World War II. He then founded Erie Chemical Co. (Boston) from which he retired several years ago. He is survived by his wife Sylvia.

M. David Haynes died April 11, 1987, in a York, Maine hospital. Dave graduated in Course X, chemical engineering, and had his service career of 37 years with Tidewater Oil Co. (later, Getty Oil). He retired to a life of civic activities and the pleasures of a waterfront home at York Beach, Maine. His special joy was boating and operating enough lobster traps to keep his family supplied. Dave became widowed about five years ago but leaves two daughters, five grandchildren and six great-grandchildren.

Philip S. Taylor died April 14, 1987, while visiting his son in Lancaster, Pa. Phil graduated in Course X, chemical engineering. His professional work was largely in cellulose chemistry and textiles—most of it with The Kendall Company in Walpole, Mass. In writing to us about Phil's death **Charlie Southwick** says, "Phil was more than a friend, he was my partner in all the many lab projects of Course X. But the tie that really bound us was our thesis on the high pressure synthesis of methanol. Our ways parted until we met at the 50th class reunion when we renewed our friendship." To the families of these deceased classmates we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix Street, Winchester, MA 01890

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Gordon R. Williams of Weston, Mass., says that he and his Olive live quietly in Weston and enjoy retirement. . . . They had a letter from 'D.A.' Wilson. She apparently has taken more than a year to catch up answering letters of sympathy following John's death. . . . **John Happel** of Hastings-on-Hudson, N.Y., writes, "Dottie and I spent a couple of weeks in Guadeloupe last March. The climate there is always warm and sunny at that time of year. I am busy with catalysis, having just written a book on the subject." John also reported that he expected to go to Paris last June for a visit with French colleagues and then a few days in northern Spain to see the cave paintings of prehistory.

Hunter Rouse of Sun City, Ariz., has made a gigantic contribution to the field of hydraulic engineering during the past 60 years. His last three technical papers have been published—one each in Santiago, Rotterdam, and New York. He says, "In addition, several dozen of my colleagues and former graduate students combined to produce a volume in my name. Old age sure has its compensations." The commemorative volume, *Megatrends in Hydraulic Engineering*, is edited by Maurice L. Albertson and Constantine N. Papadakis. It also recognizes the contribution of Ralph L. Parshall, inventor of the Parshall flume and the vortex tube sand trap. The papers in this volume not only bring the reader up-to-date on the state of the art but also look into the future on a variety of subjects.

A few years ago, **Fred S. Eastman** retired after 41 years as professor of aeronautical engineering at the University of Washington and moved to a retirement community in Medford, Ore. His hobbies, lawn bowling and hiking, created interest among his co-residents. Also, he soon became known as "the extremely skilled leader of the Wednesday Walk" in *Hilltopics*, the manor's monthly news. But it was not for that skill that he was summoned, along with his wife Louise, to an award banquet at Seattle's Sheraton Hotel early last November. He was chosen by the prestigious Museum of Flight to receive one of its four 1986 Pathfinder Awards honoring persons whose vision and efforts have furthered the science of aviation in the Northwest. During his 41 years at the University, Fred launched the institution's new aeronautical engineering department, expanded its program to provide for a master's degree and later a doctorate, and designed (in the 1930s) an ingenious electrical balance system that resulted in more reliable wind tunnel data—a system that he refused to patent lest its use be thereby diminished. At the banquet attended by over 800 persons, Fred had an opportunity to meet many of his former students, most of whom are now prominent in aeronautics and aviation.

I have a note from **John F. Joyce** of Drexel Hill, Pa.: "Except for a prostrate condition about eight or nine years ago, I had not been hospitalized since graduation. All that is changed now. Last October, I was sent to the hospital because of blocked bile duct. Unfortunately, the blockage was due to the growth of a tumor around it, which slowly choked it and closed the bile duct. I was operated on in late October and after three weeks came home to recuperate under the care of two doctors. I have just finished five weeks of light radiation, which I handled without any difficulty. Through all these proceedings, I did not suffer any pain at all. Mary and I are leaving for Florida early in March for rest and further recuperation. I have lost quite a bit of weight, which I hope to regain in the warm and sunny climate."

I regret to announce the deaths of the following classmates: **John J. O'Brien** of Watertown, Mass., on January 12, 1987; Dr. **Emanuel B. Hershberg** of West Orange, N.J., on January 22, 1987; **Arthur J. Bearse** of Punta Gorda, Fla., on February 14, 1987.

John O'Brien was born and brought up in Cambridge, Mass., and received a bachelor's and master's degree in chemistry. He worked for R.W. Grace Co. for 43 years as a chemist until his retirement. He was a member of the M.I.T. club and a resident of Watertown for 48 years. He is survived by his wife Mary and three sons.

Arthur Bearse was a personal friend of your secretary and **Putnam Cilley** of Sharon, Mass. Arthur and Put were very good friends from way back. They were always together at all the M.I.T. and class functions, and I got to know them through their joint attendance of Alumni Day for many, many years. In recent years, Arthur's health was impaired, but he made an effort to attend the class day festivities just the same. Put sent me a note about a year ago that Arthur was too ill to attend last year's exercises. Put and I were pleasantly surprised when he showed up in company with his wife. In parting that day, he said, "I guess this will be my last attendance." Arthur worked for Sylvania Electric Co. in Danvers as production and design engineer. He is survived by his wife Claire, a son, and three

daughters.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

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This month's notes are being written on board the *M. S. XiLing* during the course of a five-day cruise on the Yangtze river from Chongqing to Wuhan. The cruise is part of a 21-day tour that we are taking in China. We have been particularly impressed by the bright, alert, outgoing and apparently well-fed children that we have encountered in large numbers wherever we go, and by the amazing number of high-rise residential buildings (particularly in Beijing), said to consist essentially of 350- to 400-square-foot apartments and providing significant evidence of the People's Republic's effort to house its burgeoning population.

Last spring, Maggie and **John Scheuren** made an extensive trip to Europe, ending with a nostalgic visit to Sondrestrom Air Force Base in Greenland, where they received "red carpet" treatment from the U.S.A.F. Command and the Danes. John reports, "I flew Maggie all around the area and showed her the edges of the icecap. After spending 11 years off and on in the North, I had great joy in showing my Maggie around. I was reminded of **Chuck Habley** when I saw the C-130 ski planes which now re-supply the icecap radar sites. We designed these stations around Lockheed's C-130 in the mid'50s and it took a while to work out the details. During our correspondence with Lockheed I noticed 'C. H. Habley, vice-president of military sales' for Lockheed. It turned out that he had been the sophomore left tackle who played alongside me when we played at M.I.T." John recalls that the football team on which he and Chuck Habley played included **Johnny Steele**, who left M.I.T. to go to West Point and eventually retired from the Army as a brigadier general. During the mid-'50s he commanded the Nike units in the Boston area, and the Steeles and the Scheurens visited back and forth at that time. John further recalls that at the time of the 30th reunion **"Mako" MacKinney**, his wife Doris, and their daughter stayed with the Scheurens at their Cohasset home. After the reunion John drove the MacKinneys to the airport and turned them over to **Bill Cullinan**, who was going to fly them to Maine. John has apparently become bored with his retirement in Tucson and is remodeling his beach house in Hingham, Mass., with the idea of moving back there.

Joe Kania sends an extensive autobiography of his life and career. Certain aspects of this material have been previously reported in class notes—his career with Pemberton Securities as a specialist in mining and oil stocks, his extensive traveling on behalf of the Vancouver Board of Trade, and his unique, self-designed house in Vancouver. New items of interest in his latest report are details of his early life. Joe was born in Vienna in 1901 of a Czech father and a Viennese mother. The family emigrated in 1913 to British Columbia, where his father died several years later after a long illness. Because of his father's illness and death Joe was unable to go to high school. During his teens, he worked at a number of daytime manual jobs and played the violin at silent movies and dances at night. At age 20 he decided to try for a college education and after four months of intensive home study, was able to pass the entrance examinations at the University of British Columbia. He received a B.A.Sc. from U.B.C. in 1926, an M.A.Sc. in 1928 and a Ph.D. in geology from M.I.T. in 1930; all-in-all a rather remarkable performance for an immigrant youngster. Joe reports having seen **Guillermo Zuloaga** in the course of trips to Caracas. (While writing these Notes on the XiLing, I met a Vancouver neighbor of Joe's.)

After two years in Wilmington, Marge and **Hal Spaans** have decided to move again, this time to Willow Valley Lakes Manor, a "total care" retirement community in Willow Street, Pa. During their sojourn in Wilmington they found it to be a "dynamic smallish city with many cultural opportunities. For example, we have been guiding at the Rockwood Museum, an interesting English style country house." Their holiday season was disrupted by Marge's trip to the hospital with pneumonia, but she was back home and recuperating slowly at the time that Hal wrote.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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I am sad to report that **Clifford Harvey** passed away on April 1, 1987. An electrical engineer, Cliff was vice-president and cofounder of the Harvey-Wells Electronic Co. from 1940 to 1960 when Whitten Machine Co. purchased his company. He continued working for the company until he retired in 1972. He is survived by Helen Harvey.

A note from **Ben Steverman** included a letter from **Gene Branca** reporting the death of **Martin J. Feeney**. Gene's letter reads as follows: "While in Florida this winter, I received a call from Boston notifying me that one of our classmates, Martin J. Feeney, died on March 7, 1987. I understand that his death was cancer related. Martin graduated from Course IV-A and attended several of our reunions. Ben remembers Martin as a warm and gentle man—**Edwin S. Worden**, Secretary, P.O. Box 1242, Mt. Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158

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Lawrence Berk is the founder and present chancellor of Berklee College of Music. The National Association of Jazz Educators presented Dr. Berk the Hall of Fame Award in an Atlanta convention attended by over 3,000 members and guests. This honor was due to his musical contributions and dedication to jazz education for 25 years.

The late Professor **Carroll L. Wilson** spent much of his career seeking solutions to world-scale problems. A fund in his honor gave two $5,000 graduate scholarships and two $2,500 undergraduate scholarships this year. There is a display developed by the M.I.T. Museum honoring his life and works.

James D. Abbott of New London, N.H., writes that he regretfully won't be able to make our 55th reunion because he has a commitment to join a group clearing hiking trails in Cold River Valley. He continues to be active for the U. S. National Forest System. James has just completed making a software computer program that does in two hours what regularly takes 12 hours. He sends his best wishes to everyone for many more fruitful years.

Commander **Leo Tyburski** (U.S. Navy, retired) tells us he is about to visit his son, daughter, and grandchildren in San Diego. . . . **Edmund McLaughlin** writes, "Since moving to Maine, my wife and I find the winters are cold, so last year we went south—way south to the straits of Magellan and up through the Chilean fjords. It was cold! This year we will get some intellectual heat by attending a seminar at Cambridge University." . . . **Don Gilman** writes us his health will not permit him to attend our 55th reunion. He sends best regards to all.

We have received the sad news that **J. Stillman Haynes** died on March 2, 1987, and also Captain **Leonard H. Saunders** on March 7, 1987.

Royal Jackman , a lifelong friend of **John Slater,** sends us the following obituary about John, who died in March 1987. (The Slater family encouraged and enabled Royal to attend M.I.T. as a graduate student—"an experience of enormous value to me," says Royal.) John worked in the East several years before joining the Autonetics Division of North American Aviation, Inc. He was instrumental in the development of inertial naviagation systems and published several technical papers and books on the subject, including "Twenty Years of Inertial Navigation at North American Rockwell." He retired in 1970 as chief scientist, Navigation Systems, Autonetics Division, North American Rockwell, Inc. He is survived by his wife, Eva; two sons, Dan and Mark; and a daughter, Miriam.—**Melvin Castleman** , Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907



Lawrence Berk, '32, founder and present chancellor of Berklee College of Music, is here honored by the National Association of Jazz Educators with their Hall of Fame Award.

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Norm Spofford, Course I-A, has been in Taiwan for the last 11 months helping to teach English at a private school in Taipei. He expects to do some more traveling in the Orient. . . . **John McAleer** of North Kingston, R.I., is active in "RI Save the Bay"—planning, waste disposal, recycling, and town and shoreline activities. He was chief, Coastal Branch, Planning Division Office; chief of engineers, Washington; and staff of the Marine Board of the National Academy of Science and Engineering. . . . **Tom Fitzpatrick**, architecture, retired 17 years, lives in Highlands, N.C., in the summer and Savannah, Ga., in the winter. (I'll look him up.) He has three sons and five grandchildren and travels extensively. He might attend our next reunion. (Would be his first!)

Bert Tashjian, architecture, received two awards for his design of bronze doors for the Armenian Diocese Church of America, New York City. . . . **Don Winkler**, electrical engineering, retired, lives with his dog, is active in the Men's Club of Wakefield, and is revisiting the Quannakowitt Players for whom he formerly did the lighting.

A note to **Beau Whitton** from **Jack Andrews** corrects a report in the February/March issue of the *Review*, p. MIT 16, the main thrust of which is that it was **Jermain** and not **Jack** who retired from teaching, had shoulder surgery, and is doing well and is back, by this time, on the tennis courts. Jack also reports that **Charlie Britton** is now at 9 Vane St., Wellesley, MA 02181.

Word has come of two deaths: **Bernard D. Lucey**, 59 Grove Rd., Wollaston, MA 02170, on December 2, 1986, and **Gustave E. Kidde**, 1200 S. Orange Grove Blvd., No. 16, Pasadena, CA 91005, on March 21, 1987. We extend the sympathy of the class to the families of these class-

mates.—**William B. Klee**, Secretary, Box 7725, Hilton Head Island, SC 29938

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Reverend **Joseph A. Hahn,** writes, "Guess there's no rest for the wicked. I'm off to the Near East (mostly Israel) in a couple of weeks, then on to Italy and Spain to visit friends that I knew some years ago. Made another trip to Nicaragua early in the year and found that Americans are still liked. Recently put in two weeks in Puerto Rico doing interviews and taking pictures for our magazine," *Revista Maryknoll*.

Dick Bell writes from Scottsdale, Ariz.: "I sold my last business in June 1985. I now consult for the United Nations and IESC overseas, locally for SCORE and the Veterans Administration and the SBA for management advice to both veterans and others who wish to start their own small business—all of which is very challenging, very rewarding, and often very frustrating. But, it does keep me very busy, which is certainly good for me. We just returned from Brazil and before that were in Columbia, South America, consultations. Will be leaving shortly for China. Some of these jobs let me take Anne, but some, such as West Africa, do not offer facilities for wives.

"Just had a visit from Joseph Lieberman, '53, and his wife, who were on their way to Palm Springs. We visit more or less regularly with Gordon Lister, '30, and wife Louise of Green Valley, Ariz.—sometimes here and sometimes there. Perhaps you will recall that his brother, **Donald Lister** was in our class. Since we enjoy fine weather the year-'round, we hope that those of you coming out to Arizona will contact us in Scottsdale."—*ed.*(**Robert M. Franklin,** Secretary, P.O. Box 1147, 620 Satucket Rd., Brewster, MA 02631; **George Bull,** Assistant Secretary, 4601 N. Park Ave., Chevy Chase, MD 20815)

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Last May 7 **Rollin Morse**, a former Course X retiree from Du Pont, received the Jefferson Award in recognition of his extensive work on numerous restorations, political, and community service committees and projects in Columbia, Lancaster County, Pa. He and his wife Virginia moved to Columbia in 1977 and, from the descriptions of the things that the two of them have done together and separately, the area will never be the same as it once was. Rollin is interested in antiques and also spends time with his computer and word processor. The latter has helped him especially with his fundraising projects and a study he is doing on banking in Columbia. He categorizes his hobbies as technical, not recreational. In addition to his work on the computer and banking, he's an avid photographer. He and Virginia live at 30 S. Second St., Columbia, PA 17512.

I had a chance to talk to **Leo Beckwith** recently and am glad to report that he is recovering in fine manner from successful bladder removal surgery in early April, 1987. . . . **Jack Holley**, San Diego, Calif., writes, "Just returned from the Philippines. Folks there are more bright-eyed than before Aquino. Could be a vast improvement in the local economy is in store. Imagine a resurgence of grains, sugar, and copra from the Philippines into the world markets. And don't forget the metals, especially gold and silver. I've been thinking of investing a few bucks over there. Thought you might like to know. Anybody for a stainless steel jeep?"

I am sorry to report the deaths of three more '35ers: **Clarence D. Davis** on January 26, 1987, in San Diego; **Edward N. Richards** of Raleigh, N.C. on February 1, 1987, and **Frank Chauncey Whittelsey** in Barrington, R.I., last August 1986.

My one bedroom apartment on the second floor of a complex of senior housing units is beginning to look more and more lived in. After two years in a small rented room, cooking on a hot plate and sharing the bathroom with two other roomers, it is well worth the wait to move in. I'm slowly getting used to living alone but not being lonely. And now the golf season starts! Write to me.—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02254

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Page MIT 6 of the April 1987 *Review* has a report on the 75th anniversary meeting in Tokyo of the M.I.T. Association of Japan last October. **Thomas Kato** was one of eight cited for long-term active membership. I have thought of Tommie from time to time over the years—what wrenching feelings he must have suffered in the war! His response seems indicated in the reunion biographies: a series of responsibilities for American and Japanese entities promoting bilateral economic development.

The same article shows a 1929 picture of the visit to Tokyo of Robert H. Richards '68. This was the professor emeritus who at about the same time endowed the annual Richards Cup Race and medals which our class crew won in 1934. I do not have a picture, and my recollection of its members is dim: **Gordon Thomas**, stroke, **Bill Beckwith**, **Herb Borden**, **Ford Boulware**, **John Easton**, **Art Jaeger**, **Tom Johnson**, **Mike Kuryla**, **Bob Lutz**, **Ed Pratt**, **Scott Rethorst**, **Lou Smith**, **Milner Wallace** and myself, with **Larry Kanters** as cox. This puts 14 men in an eight-oared shell, which would have trouble making it to the finish line. So please, oarsmen, let me know my errors of commission and possible omission.

Notes from Tom Green, '26, and clippings from the *Hartford Courant* and the *Manchester* (N.H.) *Union* (sent by **Bill Healy**) report the death of **Louis Proulx**, Course VII, March 24. Tom tells of Lou's help in keeping the M.I.T. Club of Hartford healthy during the war years and of members' fond moniker for him—"Prowl-Ten." Lou devoted his life to public and industrial health and safety for the State of Connecticut and was early active in air and noise polution measures. He was an executive of the Hartford area Boy Scouts of America, and ham radio operators knew him under call letters N1BHD. After retiring, he and Eva moved to Manchester and set up a photo business with son Lawrence.

Belated news of the death of **Francis "Pete" Peterson** last November 16. Winifred died a month earlier, one year short of a 50th anniversary. Word came from their son Kenneth to the Alumni Office, and in a response to **Eli Grossman** from son David when he came upon a Christmas card to his parents. Pete had a very active life of service to Scouting, of travel by car throughout North America and Europe, and 43 years of research, writing, and personnel work with Texaco. This was notwithstanding severe disabling polio contracted while a major in ordnance during the war. Cheers for the lives of Lou and Pete!

As promised last issue, herewith the complete roster of Institute awards to '36ers to date: the Harold Lobdell Distinguished Service Award to **Eli Grossman** in 1981 for service of "special depth over a sustained period;" the Bronze Beaver Award to **Edward Nicholson** in 1975, to **Alice Kimball** in 1984, **Louis Stahl** in 1985, and **Henry Lippitt** in 1986. Henry's citation was in the February 1987 notes. We all know Alice's contribution and could write our own kudos, but I like the official citation's expression—"an indefatigable catalyst for communication among her classmates. . . . a meeting of the class is almost inconceivable without her active presence." Lou's citation reads in part " . . . masterminding class reunion gift efforts from their inception. . . personally generous with his own resources. . . long personal and intense support of M.I.T." I do not have **Ed Nicholson**'s citation, but can write one of my own, having served under him on the Educational Council when he was chairman of the north Jersey area. Ed joined us as a graduate student in Course X, after getting a B.S. at University of Chicago. Notwithstanding that limited exposure, he worked long and hard for the Institute in an area of New Jersey that generated many applicants for admission to freshman classes. In the 50th reunion picture, you will find him 12th from the right in the middle row.

Lastly most mostly, **Hibbard Summersgill**, who passed on last December (see May notes), received the George Morgan Award in 1980, one year after it was established "in recognition of sustained excellence in all aspects of Educational Council activity, dedication to the Institute, and exceptional standards in the execution of council responsibilities." Hib, a member of the Alumni Council from 1979 on, was "Mr. Connecticut Valley" to alumni in that area, chairing the MIT Club, writing its newsletter, heading the telethon, and on and on. Wife Jean was his able supporter, opening their home for meetings and workers.

Just in time for this issue's deadline comes word of another mini-reunion at Alice's home on Hartland Pond, West Hartland, Conn., October 24. A note to her, Box 31, zip 06091, or a call to (203) 379-3807 will help in planning food and perhaps accomodations.—**Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745; **James Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Charles P. Cardani of Hamilton, Mass., retired in April 1984 from self employment. Prior to this, he was with Polaroid from 1971 to 1974 and before that was with the USM Corp. from 1948 to 1971. Charles plays golf, is interested in crafts, and is active in Scouts, American Legion, and Masonic Lodge Shrine Activities. He has traveled all over the U.S., southern Canada, and northern Mexico. In the navy he visited many places in the Pacific, including Hawaii, the Philippines, and Japan. Wife Jean's main interests are sports, travel, and gardening. They have two sons, Stephen and William, and one granddaughter, Heather.

This will supplement my previous report of the death of **Eric D. Swenson**. His wife Ruth writes, "Gifts in his memory are being made to the Scholarship Loan Fund credited to the Class of 1937. Inasmuch as he was fortunate enough to have participated in this self-perpetuating plan and was eagerly anticipating the 'Big Reunion' this year, I feel sure he would have approved of this type of memorial. My very best wishes go to the class for a successful and happy reunion program in their banner year."

I regret to report the death of **Mary Jean Montgomery**, who died December 25, 1986, at Baptist Hospital in Tennessee.—**Lester M. Klashman**, Secretary, 289 Elm St., Apt. 71, Medford, MA 02155

38

Each May when these class notes are due,
Nowhere in sight is **Bruneau, Lou**.
Our secretary goes away
To London and the Firth of Tay.
He feels quite free his notes to shirk,
For he has me to do his work.

Clark Robinson's a ham, 'tis true,
Call N V 7 W.
He's active on the HF bands.
He too fights fires on forest lands.
That ends Montana news to which
I'll add my monetary pitch.

We're now in our reunion year,
Last chance to act is drawing near.
It's time to give the class a lift
And send in your reunion gift.

Remember it's a one-time thing,
So loosen up the old purse string

And dig into your piggy banks
You shall have our heartfelt thanks.

For the last item of news, doggerel is not suitable. We regretfully announce the death on April 26 of **Given Brewer**. He was a nationally-renowned stress analysis expert.—**Ed Hadley**, Assistant Secretary and Reunion Gift Chairman, 50 Spofford Rd., Boxford, MA 01921

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Bill "Doc" Wingard announces our 50th reunion committee has four official volunteers: **Sid Silbur**, **Dotie Casselman**, Doc himself, and me. As a fun indicator of class of 1939 spirit and response we invite each classmate to pick up the phone or drop a note to any of the four persons above-named to say you are planning to attend our reunion at Chatham Bar Inn during 1989 and to relay some news about classmates and yourself.

Prilla and **Gus Hunicke** provide their talents to manufacture timing devices; some of which are already set to direct their 38-footer to our 50th reunion. For many years they have been cruising near Martha's Vineyard and Block Island, but, so far, they have not reported participation in any of the Woods Hole projects such as finding and exploring the Titanic.

Bill De Lia is enjoying retirement from his engineering and construction business and divides his time between Northville, N.Y. and Hilton Head Island, S.C. and Golden Beach, Fla.—**Hal Seykota**, Secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

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Activity has been started in planning for the 50th reunion in 1990. Several suggestions have been made for a resort for the weekend following the events at M.I.T. Locations in Connecticut and on the Cape are being investigated. As the committee becomes better established and plans begin to firm up, we will keep you informed. In the meantime, any ideas, thoughts, or suggestions that you might have will be most welcome. Let us know what you would like.

Ed Bernard received a letter from **Leo Pach**, 57 Union Street, Apt. 41, Montclair, NJ 07042. Leo says, "If you know of a mechanical engineer interested in codes and standards for stress calculations, I would like to hear about him."

Kingsbury T. Jackson writes, "In addition to public service and work in my consulting firm, Contract Consultants, I have been getting more involved, with several partners, in real estate. We are finding that, contrary to expectations, the new tax law has not hurt and, in some cases, has improved opportunities for productive real estate investments."

From **John C. Quady**, the following: "I retired from Northrop Advanced Systems Division in May 1986, where my job was project engineer, systems integration. This is my third attempt at retirement. If I can learn to live on a fixed budget, it may be my last."

Don Severance, '38, reports that **Harlan H. Davis** died suddenly of a heart attack on May 2, 1987. "Hal" was actively involved for decades in alumni affairs in the Chicago area. Among his many activities, he was solicitor for the Second Century Fund, member of the Educational Council, director of the M.I.T. Club of Chicago, and a member of the Leadership Committee for the M.I.T. Leadership Campaign. Although he was a longtime resident of Naperville, Ill., he most recently lived in Oakbrook Terrace. News of his death comes from his son, Harlan R. "Nick" Davis, '75.

Keep those notes flowing to me. Many classmates are interested in your activities and your reactions to retirement.—**Richard E. Gladstone**, Secretary, 1208 Greendale Ave., Needham, MA 02192

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Albert W. Kush, Flintridge, Calif., died on January 24, 1987. . . . **Arthur S. Spear** retired as chairman of Mattel, Inc., . . . **Theodore V. Ferris** has retired after 32 years as project manager and manufacturing consulting technologist of Monsanto. Ted is living in Longmeadow, Mass., with his wife Doris and still does part-time consulting. Their five children are all married, prosperous, and live nearby.

A large French-government-owned telephone equipment company, Companie Generale Electricité, bought Lynch Communications Co. of Reno, Nev., the parent firm of Transcom Electronics of Portsmouth N.H. The French firm, a $16 billion company is known as the "General Electric of France." In the late 1960s, Transcom was in financial trouble but was turned around under the guidance of **Edward Beaupre**. The company's business has expanded rapidly with the breakup of the Bell system.

Edward G. Sherburne, Jr. is the publisher of *Science News*, published since 1922 by the nonprofit Science Service. *Science News* reached its highest circulation level in 1986, more than 215,000. "We are different from other science magazines because, first of all, we're a weekly," says Ed. "We are also a news magazine and what I would call a quasi-journal that appeals to a highly-educated readership, nearly half of them scientists."

Two prominent magazines—*Science 86* and *Science Digest*—folded last year. A journalist poked fun at the conservative management style by remarking that *Science News* survived the 1986 shakeout "for the same reasons cockroaches would survive a nuclear war." It is your secretary's opinion that *Science News* is essential reading to keep up with fast-changing world events.

Neill G. Wade III, retired, finds recent air fare reductions to his liking—his grandchildren are in California and Florida.—**Joseph E. Dietzgen**, Box 790, Cotuit, MA 02635

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Alan Katzenstein just completed a new study concerning the relationship of environmental tobacco smoke to lung cancer. It analyzes the evidence in 14 studies listed by the National Academy of Sciences. He concludes that the concern about lung cancer for non-smoking Americans is overstated and not supported by the data. Good news for us non-smokers!

Big, quiet **Charlie Taber** who lived on the third floor of the Senior House and graduated in Course XV, died after a fall at his business, Miller Machinery in California. He is survived by his wife, Lois, and two children, Charles, Jr., and Shaula. . . . **Liang Chang Ho** who received an S.B. and an S.M. in Course VI died in Shanghai in November, 1984. This must be one of our tardiest obits. Liang completed his undergraduate work in three years and was active in the Chinese Students Club. He was chief engineer of the Shanghai Institute of Metallurgy and one of our very few classmates in the People's Republic of China. Next month brings the report on our 45th Reunion! But in the meantime, how about some news? We are really bereft and will now have to invent stories. Be warned!—**Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

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Urged on by **Feingold**, **Hoey**, and **Rorschach**, the 45th reunion committee has made great progress. Co-chairmen **Mort Spears** and **Ralph Leader**, accompanied by wives Dot and Barbara, together with Marge and **Ken Warden**, spent a March weekend at the Viking Hotel in downtown Newport, R. I. Pleased with the accommodations, they designated this as the reunion headquarters, then went on to reserve the Vanderbilt "Marble House" on the beach for the cocktail party and dance. According to Ken, the Viking is within walking distance of everything worth seeing in Newport. For the real aficionados, there will be guided tours of historic houses. June 3-5, 1988, has been selected for the reunion weekend.

The 45th reunion is generally a valley between the peaks of the 40th and 50th, so **Dick Feingold** plans to write to about 100 "hard core" classmates, passing along the news, exchanging program ideas, and boosting attendance.

It's only a few months away, so get your affairs in order and come to Newport.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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It is our sad duty to report that **Ed Jones'** wife, Phyllis, died unexpectedly in March, 1987. She had had a brain operation in October but was recovering satisfactorily. Our deepest sympathy goes to Ed.

Stan Skelskie has been elected president of the Georgia Association of Food and Environmental Sanitarians. Stan is president of the Shuster South Division of Herbert V. Shuster Inc., an international consultant organization to the food, drug, cosmetic, medical device, softgoods, and chemical specialities industries. He holds several patents in food processing and has developed numerous food products, the most famous of which is Ocean Spray's *Cranapple*. Stan is presently living in Roswell, Georgia, and continues to be as active in community affairs as he was when he lived in Westwood Mass. where he served as chairman of the Board of Health. In Roswell, he was appointed by the Mayor to the Board of Design for Limited Access of Roswell. He also serves on the budget committee of the 120 year old Atlanta Temple. Stan was a member of the World War II "Shaftees."

Ed Coan writes to us from Ellsworth, Maine, that he is presently president and chief executive of I.T.P. Inc. He has been manager of operations of the Early Warning System in Greenland, systems engineer with the NASA Satellite Communication Experiment and manager of testing of the L.E.M. landing radar on the Apollo program. Ed has had two patents issued and has published five papers on satellite communications.

Joe Alexander tells us that he is a business consultant and broker. He and his wife, Rochelle live in Newton, Mass., where he is director of the Newton Taxpayers Association and commander of a veterans post. Son Steven has graduated from Harvard and M.I.T. and son Robert has graduated from Rensselaer.

From **Melissa Teixeira** comes this news: "The class of '44 has done it again! For the fourth time in the last seven years-'81, '83, '84, and '87-there were more people from '44 than any other class at the annual fiesta sponsored by the M.I.T. Club of Mexico. On the last day of the fiesta, **Peter Matthews**, Carmen and **Bill Van Ravenswaay**, Marge and **Dick Whiffen**, and I met at lunch to celebrate Bill's 65th birthday. Bill retired from Caltex Petroleum in December, 1986. The Whiffens have sold their business and have moved to Bucks County, Pa. Peter is business manager and assistant treasurer with Draper Labs in Cambridge." Melissa also informed us that Dagmar and **Arturo Morales** were married in October, 1986, in Germany. Our very best wishes to them both.

Your reunion committee met in Newton on May 6th to talk about locations for the 45th reunion in 1989. Present were: Jane and **Lou Demarkles**, Anita and **Les Brindis**, **Stan Warshaw**, Ruth and **Norm Sebell**, Janice Kispert, **R.J. Horn**, **Melissa Teixeira**, Jim Baird and Diane and **Andy Corry**. Norm reported that he had received many suggestions in response to his February letter. They are all being considered.—Co-Secretaries: **Andy Corry**, Box 310, W. Hyannisport, MA 02672; **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181

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Jack Walsh and his wife Zelda are working out in a health club three times a week to keep their bodies in shape. They are also active in their church and the Tres Dias community to heal their souls. They plan to continue working. Zel is an elementary school teacher, and Jack is working on methods and cost control of electric transmission and distribution systems for Public Service Electric and Gas Co. in Newark. Since two of their sons are living in N.J., they plan to keep their home in Nutley. They love the easy access to New York City, the transportation facilities, and the ocean, and they have many good friends in the area.

Barry Bloom is president of Pfizer research in Groton, Conn., and since 1973 he has been a member of the Pfizer board of directors. Recently he was elected to the board of directors of Southern New England Telephone Co. He is a member of the board of directors of Oncogene Science, Inc., the board of trustees of Connecticut College, and the State of Connecticut Technology Advisory Board.

Jim Guida completed a great hiking trip in Greece and Crete. . . . **Elliot Bates** has retired. He is working on Literacy Volunteers and adult education, including English as a second language. . . . **Ed Kosower** continues as professor of chemistry at University of Tel Aviv and as adjunct professor of chemistry, University of New York, Stony Brook. His publication total is up to 240 articles and two books. . . . **Walter Lowrie** has retired from Martin Marietta after 38 years. His last assignment was president of Orlando Aerospace.—**Marty Billet**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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Back in February, the *Boston Globe* ran an eyebrow-raising feature article about **Hilarion Henares**, who has been making news in the Philippines ever since graduation. Larry has headed several businesses in the Philippines, has been a cabinet minister, and is now widely known as a lecturer, a commentator on television and radio, and a political columnist. "When I was at M.I.T.," he told the *Globe*, "I felt respected for my talents and abilities, but when I got back to the Philippines and saw all those GI Joes fresh out of correspondence school, strutting around acting like the blue-eyed redeemers of the brown-skinned race, and I saw how the Filipinos respected them more than they respected someone like me, I got very upset." And upset he has remained because his column, "Make My Day," in the *Philippine Daily Inquirer* is noted not only for its humor but for its biting cricicism of most things American. "I write," he told the *Globe*, "to slay the American father figure inside every Filipino. I write to educate the Filipino people." Said one Filipino businessman: "Larry is very adept at making a very funny mountain out of a very small molehill, but the end result is funny and drives the Americans crazy in the process."

A piece of paper often accompanies communications from the Institute to graduates all around the world. On it is space for a message to the secretary. We love those little pieces of paper because they mean we have something to write about. One such (and only one) reached me last week (April). It reads: "**Kenneth H. Rogers** currently is senior staff engineer on laminar flow control at McDonnell Douglas, Long Beach, and is confident that the LFC technology holds promise of significant improvements to future air transports. He is designing a small, high-speed winged sailing craft in his spare time and remembers his engineering training at M.I.T. with much pleasure and appreciation."

One of nature's most terrifying and destructive phenomena—volcanoes—was the subject of a symposium in Hilo, Hawaii, last January at which scientists from more than 20 countries presented some 300 papers. **Bob Decker** organized the week-long event. Bob is a geologist with the U.S. Geodetic Survey in Menlo Park, Calif., and served as scientist-in-charge at the Hawaiian Volcano Observatory from 1979 to 1984.

In his search for solicitors for the 40th class gift, **Chuck Holmes** wrote a letter to **Ed Walz** only to receive the sad answer from Mrs. Martha C. Walz that Ed died from a heart attack at his home in Ashville, N.C., sometime during 1986 (no date given). He was 61. Mrs. Walz's letter was a touching tribute to Ed. Both had retired due to health problems, he from the field of chemistry and she from physical education. Both were in their fifties when they married, each for the first time.

In another shocking piece of news, **Marvin Asnes** died at his home in Manhattan on March 13, 1987, after a long battle with cancer. He was 58. Marvin was a campus leader while in school and continued after graduation as a leader both in business and in alumni affairs. According to an obituary in the *New York Times*, he was a vice-chairman of the Bowery Savings Bank at the time of his death. Prior to that, he had spent many years with Becton Dickinson & Co. of Paramus, N.J., a manufacturer of medical and hospital supplies and industrial safety products. While with this company, he rose to become chief operating officer and president. At the time of his death, Marvin was vice-chairman and a trustee of the Mount Sinai Medical Center, treasurer and a director of the New York City Ballet, and treasurer and a director of the Bank Street College of Education. He is survived by his wife, the former Norma Ketay; three sons, Anthony, Andrew and James; his mother, Esther; father, Louis; and a sister, Mrs. Sheldon Rothbart. Anthony, the oldest son, is a first-year master's student at the Sloan School.—**Fletcher Eaton**, Secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

50

Tom Howitt, Jr., reports that he has taken early retirement after working for Corning Glass Works for 37 years. He has been vice president of corporate development, personnel, electronic products division, science products, energy and environmental control. He retires as vice president and director of purchasing and transportation. He is also past chairman of the board of trustees of Corning Community College. He and his wife, Mae, intend to stay in Corning, New York, and enjoy their cottage on Keuka Lake in upstate New York and visit their six grandchildren located in the northeast.

Bruce L. Shakely has retired, but is keeping himself busy doing consulting work and painting watercolors. . . . **Jacob M. Shapiro** is presently senior reliability engineer for Missile Systems Division, Bedford, Mass. His daughter, Pamela, an '85 graduate of M.I.T. with a B.S. in Chemistry, is now studying for her doctorate at the California Institute of Technology. **Ken M. Eldred** is sailing a new Frers F&C 44-foot sloop out of Marion, Mass. He just developed a national airport noise impact model for the FAA to assess benefits from alternative regulatory policies.

We are saddened to hear of the death of **David L. James**, who passed away March 1.—**John T. McKenna, Jr.**, Secretary, 9 Hawthorne Pl., 10-H, Boston, MA 02114

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Ed Bronstien had the best reasons for missing our reunion last year. Ed was busily changing his marital status from widower to, as he put it, "happily married to a wonderful girl from Rhode Island." They honeymooned aboard his yacht *Dreamboat*, cruising from Florida to Maine. Ed sent along pictures of the yacht to show how appropriately it is named. Dreamboat was included



F. H. Thomas, '51

in the recent book, *The World's Most Extraordinary Yachts*. Ed is the president of the Spencer Boat Co. in West Palm Beach, Fla.

Congratulations are due to **Frank H. Thomas** on being appointed vice-president of research, development, and technical services for the construction activities of The Turner Corp. In this capacity, he will lead the company's expanded effort to increase knowledge and implementation of improved construction materials and approaches. Frank's career with Turner has advanced from various field positions to that of general superintendent and later project executive in their Chicago offices. He was designated vice-president of the Chicago office in 1973 and general manager of the Chicago territory the following year. Frank's new responsibilities will include coordinating company research and development with industry groups such as the High Rise Institute and the Construction Industry Council.

It was good news to hear that **Adolph C. Hendrickson** has successfully come through bypass surgery and is back at work full time at the Computer Sciences Corp.

Over the past years **Myron Lecar** has been studying the formation of planets in his position with the Smithsonian Institution. With a grant from the Smithsonian, he helped found and keeps close ties with the Wise Observatory of Tel Aviv University in Israel.

D.C. Whittinghill, Jr., is in his fourth year as general traffic manager at the Nashua Corp. He writes of being busy negotiating carrier contract discounts, culling his salaried staff to leanness, and breaking up jurisdictional low productivity pockets.

My supply of the class statistics and associated comments that were distributed at last year's reunion is almost depleted. Many of you have claimed a set by writing to me. The deal is that you have to include a few lines about yourself and family for these class notes. For those of you still wanting a set, please hurry. This may almost be your last opportunity to obtain these hallowed documents.—**Martin N. Greenfield**, 25 Darrell Dr., Randolph, MA 02368

52

The Student Financial Aid Office has an annual ritual, thanks to the Class of '52 Scholarship Fund. Each year, after selecting the recipient, they notify our class president (**Art Turner** at the time of writing), who sends along the information to the class secretary, who passes the information on to you. Christine Mleynek writes Art as follows:

"I am pleased to report to you with our selection for this year's class of 1952 scholarship recipient. Once again, because we do not have a direct descendant of the class of 1952 enrolled as an undergraduate, we have chosen William L. Jarrold, from the class of 1989.

"William is from Easton, Conn. He is a sophomore in the physics department. He plans to continue for his Ph.D. and then pursue a career in teaching and research. William is a member of the M.I.T. crew team and devotes many hours per week to train with the team. He is also a member of the M.I.T. choral society and has been involved in Project Contact, a program to acquaint prospective applicants with M.I.T. He has also

served as a student representative on the "Committee of Integrated Curriculum," a committee designed to study the virtues of a combined liberal arts/technical program. William is the son of Jerome T. Jarrold, M.I.T. class of 1948.

"We are pleased to present William as this year's Class of 1952 Scholar. He is an outstanding student and we are confident he will uphold the honor of this scholarship.

"On behalf of William and M.I.T., please accept our gratitude for your collective generosity. We appreciate your interest in our undergraduate students and the sort of higher education that M.I.T. offers."

In his covering letter, Art comments, "I guess that we have not been prolific enough, or perhaps our progeny are not smart enough." I prefer to think that we, or at least those of us with children at M.I.T., are too well off for financial aid. On the basis of past experience, though, I doubt that Ms. Mleynek's statement that no children of classmates are enrolled as undergraduates will be universally accepted. I am looking forward to hearing from those who, for any reason, feel they have undergraduate children at M.I.T., and can let us know why they hold that opinion. While we may be disappointed in not having a class descendant win the scholarship, William Jarrold seems a worthy recipient, and a credit to our intentions in creating and supporting it.

I benefited from a business trip **Sandy Isaacs** took to San Francisco when he came down to Palo Alto for the evening last April. Sandy is currently working for Oxfam America, overseeing the computerization of their office functions. (The Bay Area is not notably afflicted with famine: Sandy was attending a meeting on computers.) I am glad we had the opportunity to be together again. We had a fine evening of talk.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

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No news was received during the month preceding my writing these notes, but I wanted to take this opportunity to make sure everyone is thinking about our 35th class reunion in June. I hope to have more information on time and place in our next set of class notes. It will be nice to see each other and renew old friendships. Perhaps we can get a turnout that will exceed the one for our 25th reunion.

Also, our reunion chairmen can use all the help they can get, so if you would like to lend a hand, please drop a note to **Fred Brecher**, class president, or me.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701

54

Jack Preschlack writes that he joined Spencer Stuart, an international executive search firm, as director of their Chicago office last spring. He is working with the firm's U.S. Board of Directors on search practice and is helping in senior management searches in the Midwest. Jack was president and CEO of Roberts & Porter, Inc., a manufacturer of printing supplies and inks, until about a year ago. Previously, he had been president and CEO of General Binding Corp. in Northbrook, Ill., and a partner of McKinsey & Co., international management consultants. He says that he sold his interest in Roberts & Porter in order to explore other opportunities and finally decided to re-enter the consulting profession. Jack and his family live in Lake Forest, Ill.

It is with great regret that we report the death of **John Pierce**, who died unexpectedly in his home in Lexington, Mass., last April 2. John worked in radio and data transmission technology and was well-known as an electronics engineer and inventor. He consulted for the Air Force and many Department of Defense laboratories and agencies. He joined Signatron, Inc., of Lexington in 1973 as a principal scientist and helped design underwater acoustic communications and sonar systems. He was a fellow of the Institute of Electrical and Electronic Engineers and held a number of patents. Our deepest sympathies go to his wife Alice and their two daughters.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

55

David Brooks sends a letter from Ottowa, Canada, saying that he and Toby are still married (32 years). They, like many of us, have no children at home and find it strange when they come back to visit. Both their children live in Toronto. To catch up on Dave's activities, he spent most of the middle and late 1970s organizing and running Canada's Office of Energy Conservation. Then for a number of years, he was head of the Friends of the Earth in Canada (FoE) and worked full time on environmental issues. He is still president of FoE. About four years ago, he formed a consulting firm that specializes in energy conservation and energy/environment policy links. He quotes the famous line from Tom Lehrer, "I now charge for what I used to give away free." Toby continues to work in the shelter for battered women.

David has visited Marilyn and **David Nasatir** in Berkeley and has talked with **Eldon Reiley**. Also, he just returned from Florida where he saw his thesis partner **Dick Maehl** and wife Sharon, who received her degree as a medical doctor not so long ago. Dave still says, "The best part of life is canoeing, particularly if there is a bit of whitewater and a moose or bear watching from the shore."

Ronald Lieber is currently completing his third year working in the bio-technology field of mammalian cell culture, helping to establish a new company, Invitron Corp. He says, "It's a good way to cap a career in chemical engineering."

My son, Brad Peterson, was married July 18 and then proceeded to Cambridge to enter Sloan in pursuit of his S.M. in finance and MIS. It would be an interesting poll to see how many of our children have gone to M.I.T. I'd like to hear from all of you on that issue.—Co-secretaries: **DuWayne J. Peterson, Jr.**, 201 E. 79th St., New York, NY 10021; **Robert P. Greene**, 37 Great Rock Rd., Sherborn, MA 01770

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Class Meeting: Last Patriot's Day a class meeting was held. **Ron Masser** (president), **Lloyd Beckett** (co-vice-president for 35th reunion), **George Brattin** (secretary), **Larry Goldberg** (first vice-president), **Ted Korelitz** (co-vice-president for 35th reunion), **Klaus Kubierschy** (treasurer), and **Bill Northfield** (past-president) were in attendance. (One attendee left Fort Meyers in clear 80-degree weather for drizzly 40-degree weather to attend this meeting, which shows that although dedicated, they might be able to use your input.) Other historic happenings of the day proved Seko winning the marathon, because Reagan did not extend the trade barriers to runners; the Brewers winning their 13th to tie the record; and the stock market prepared itself for the second largest upswing in history.

To give an appreciation of the 30th reunion from pre-Tech Night Pops activities to the clambake at Newport the following statistics are presented:

☐ Total cost about $35,000.
☐ Cost for all events was $990 per couple.
☐ Classmates attending all functions were 36 strong.
☐ The most popular function was the clambake.
☐ The most noteworthy event was the dinner-dance at the Astor-Beechwood. (A real take!)
☐ The wine-cooler momento consisted of a monogrammed bag with wine, glasses, and corkscrew. (This definitely gets one out of the brown paper bag syndrome; throw in a couple of earrings and you are mod.)
☐ The inclement weather did not dampen the spirit of the occasion.
☐ The next class meeting will be held in October without the benefit of the sec of the "gone" reunion, fine wine provided by a known anonymous donor. Contact one of the officers if you are interested in attending.

Mini-reunions: Considerable interest has been indicated in mini-reunions, especially in Chicago, southern California, and the Northeast. Please contact one of your officers or your secretary if you are interested in organizing or participating. Local mailing lists can be developed.

Fall 1988 class meeting: Reunions are traditionally held close to the campus during June. Interested in getting together somewhere else at another time? If so let's do it. A fall 1988 meeting has been proposed. Your input will be appreciated.

Class gift: There is always considerable talk of what the class should give or how it would like to be remembered. There have been some heady suggestions. Do you have any ideas?

Ted Korolitz formed International Trade Management Corp. out of Waban, Mass., to open new markets in the Far East and vice versa. He has been most successful in his areas of expertise, that of computer software and technology licensing, plus clients in electronics manufacturing. Previously, Ted worked with the Badger Co. and for a short period with Aspen Technology (both of Cambridge). During the past ten years, he made over 50 trips to the Asia/Pacific area, where he "met many fine people." One of these trips prevented him from making the 30th—a seminar in Tokyo and negotiations in Beijing. He and his wife Diane reside in Newton with their youngest of three daughters. The eldest teaches in the area and the midler will be a senior at Boston University. If you desire to communicate with Ted on the reunion, class affairs, or other, try ITM Corp., 136 Beethoven Ave., Waban, MA 02168, (617) 969-8540.—Co-secretaries: **George H. Brattin**, 39 Bartlet St., Andover, MA 01810, (617) 470-2730; **Irwin C. Gross**, Sweet's, McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181

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Ten months and counting to the 30th reunion. Make plans now for June 2-5, 1988. For any classmate who remains skeptical of the whole idea of reunions, all we can tell you is that we have had wonderful times renewing old friendships and making new ones, too. So, even if it's your first time, come on down!

Using his combined background in physics, architecture and sculpture, **Kent Bloomer**, professor of architechtural design at Yale, won a national competition in the arts to design a 65-foot high "Science Wall" at the University of Oregon in Eugene. Located in the atrium of the new Science Campus, Kent's Science Wall contains ornaments representing solid, molecular, bio, and astro physics.

Received a note from **Dave Christensen** telling us that he has "returned to the U.S. after eight years in Saudi Arabia as a senior corporate planner with Iramco. I am now seeking a new position on the East Coast in the Washington, D.C., area. Our children are in boarding school here and we really like the Reston, Virginia area."

Among the recently named fellows of the American Society for Medals (ASM) was **Arthur Aronson**, president and chief operating officer of Lukens Steel Co. ASM recognized Arthur for his application of "metallurgical and management principals resulting in the achievement of efficient, profitable, and rewarding enterprises in the specialty steel business." . . . **Robert Walsh** is pastor of the Unitarian Church in Duxbury, Mass. He graduated from Harvard University Theologi-



New Hampshire Governor John H. Sununu, '61, (left) and his wife Nancy attended the graduation of their son, John E. Sununu, who received his S.B. and S.M. at M.I.T.'s commencement exercises last June.

cal School and was ordained a minister in 1980.

We were indeed saddened to learn that **George Bienkowski**, professor of mechanical and aerospace engineering at Princeton University, died from injuries suffered in a bicycling accident this past fall. George had been a member of the Princeton Faculty for 20 years, and his research was focused on the theoretical aspects of fluid mechanics, rarified gas dynamics, and plasma physics. Currently, he was serving as chairman of the department's undergraduate program and student advisory activities. George was an avid runner, a member of the Mercer-Bucks Running Club, and had participated in many marathon races. We extend our sympathy to his wife, Lucinda, and their four children, Lisa, John, Andrew and Mark. A Bienkowski Memorial Fund has been established by his colleagues and friends, and contributions may be made to the Department of Mechanical and Aerospace Engineering at Princeton.

More reunion news next month.—**Michael E. Brose**, Secretary, 534 E. Broadway, South Boston, MA 02127

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Here's some news from home base. One of the nice things about moving to Washington, D.C. has been to see **Frank Tapparo** on a regular basis. Frank is approaching 20 years of service with the federal government in Washington, and as a result has a paragraph long title: Director, Europe and Pacific Forces, Office of Secretary of Defense, Program Analysis and Evaluation. Frank has two sons, one is a Marine Corps student pilot and the other is an almost-graduate of the University of Maryland. Frank is also active in the M.I.T. club of Washington.

The other joy in being in Washington is being able to unpack my golf clubs, which have been in disuse since my days in the M.I.T. golf team. With the golf course only a mile away from my house and three kids just coming into the proper age for golf, I intend to become fanatical again. Keep the notes and comments coming.—**E. Patrick Coady**, Secretary, c/o The Acacia Group, 51 Louisiana Ave., N.W., Washington, DC 20001

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John Castle sent a letter bringing us up to date on his activities. Last October, John and a group of '61 Sammies gathered at **Dave Schiffman**'s apartment in New York City for *their* reunion. They had cocktails and watched the Red Sox blow the series (the "ball through the legs game") at a local eatery. The locals, who included Schiffman, **Leon Borstein**, **Mitch Brodkin**, and **Bill Steiger**, were plainly for the Mets and enjoyed the Bostonian's (Castle and **Herb Fox**) suffering. **Mike Zimmerman**, from Chicago, and **Steve Waltman**, from St. Louis, examined the others and their teams dispassionately. They all hoisted a glass to the memory of **Sandy Weiner**, who died of cancer last year. John also writes that he is chief executive officer of a small company in Boston which sells an "automated semen analyzer," and he is traveling around the country selling this device to fertilization and in vitro fertility clinics, and checking up on old classmates. On one of these trips he and his wife Cynthia had supper with **Jack Klapper**, who is a successful neurologist in Denver. They had another meal with Lee and **Burt Golub**, who "have a wonderful hide-a-way in the hills above Golden, Colo."

Ed Sonn writes that he has changed jobs. He used to be with Data Terminal Systems, oscillating between engineering and marketing. Now he has moved over to Tranti Systems, run by Frank Trantanella, '69, in North Billerica, Mass. Ed is vice-president in charge of engineering. The company makes "point of sale" terminals for fast food restaurants. This change means that Ed can stay at home more. Instead of traveling to the Orient and California every couple of weeks, he is able to keep the traveling down to less than once per month. The Sonn family spent 17 days in China last fall on their own—they were the whole tour group (two adults and two kids). Ed writes, "We were met in each city by a guide and a driver with a van. The small group gave us some flexibility in choosing the local sights we would see and how much time we would spend." . . . A press release from Pyropower Corp., in San Diego, reports that **Joe Lestyk** is running their legal department. Joe spent the last 18 years at General Atomic, where he ran their Contracts and Law Section. Now, at Pyropower, he is in charge of commercial and government contracts as well as matters of international law. He is good at all of this because he graduated cum laude from the Western State University College of Law. When things at Pyropower aren't keeping Joe busy, he runs the San Diego chapter of the American Diabetes Association and the A.D.A. Southern California Affiliates.

At Merck Sharp and Dome Research Labs in Rahway, N.J., **Ed Grabowski** is head of process engineering. Ed and his people came up with the first chiral phase transfer alkylation, and they have recently improved the cysteamine insertion chemistry of imipenem. Ed's wife Lenore writes, "Ed's as modest now as he was back at M.I.T. Ph.D. 1965, University of Rochester. At Merck since then. Also, he lectures and publishes on French postal history." . . . A couple of months ago **Dave Rundle**, the Holyoke, Mass., city engineer, was seriously considering a move to South Hadley, where the pay was better. A bidding war between the two towns ensued and South Hadley came out on top—so that's where Dave will end up. He says that a change of scene after 18 years in Holyoke might be nice, too. . . . The *Boston Business Journal* interviewed **Jerry Grossman** last February. Jerry is president of the New England Medical Center—a big enough business to interest Boston financial types. According to the article, the medical center was in rough financial shape when Jerry arrived in 1979. He got people to pay their bills, and now things are back in the black. His methods are being used in a lot of other medical areas. Jerry is also involved with a program called Career Beginnings, which aims to encourage "tenacious" teenagers who are neither geniuses nor bums and help them get through college and into a useful life.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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"It was a dark and stormy night when I (**James Kuzdrall**, responding to the April notes) wrote to my uncommunicative but hopefully literate classmates. After 25 years of nothing momentous, I clearly should wait no longer. My only scientific contribution, thus far, has been the application of hyper-singularity to design engineering, which is closely associated with the lost art of efficient manufacturing. I work alone in an isolated lab deep in an otherwise unoccupied basement of a private home, doing solitary engineering designs for unique applications in esoteric industries. My artist wife, Harriet Winchester, enjoys a quiet and uneventful life far above the pacing and gnashing in the basement lab. She paints beautifully lonely landscapes of desolate places. The mail box rattled last year with a message from Dun and Bradstreet: a 'ZZzzz' classification, an honor reserved for firms in Intrel's growth range. They noted how few chief executive officers can stimulate 100% growth by the careful selection of one additional employee." James writes on the letterhead of his company, Intrel Service Co. of Nashua, N.H. He asks contact from anyone "working with non-simulation design automation techniques."

Bruce Eisenstein heads the E.C.E. department at Drexel in Philadelphia. The department has now "grown to 46 faculty, 1500 students and nearly $4 million in research funds." About his family, Bruce reports, "Eric (16) is starting to look at colleges, Andrew (15) is on the tennis team, and Loni (9) is enjoying fourth grade." . . . Van Nostrand Reinhold has just published **Mike Lukas'** new book *Distributed Control Systems* on microprocessor-based industrial controls. . . . Life touches us all, according to **Bill Zoller**, who is "very involved in L.I.F.E. drug rehabilitation program here in Sarasota. One of my children was in the program—no one is immune to the problem. I became so interested that I am a student again at the University of South Florida, obtaining a master's in rehabilitation counseling." . . . And a note from yours truly: I have left microcomputer retailing for distribution. Distribution Plus, of Frederick, Md., has appointed me product manager for CAD with the task to put together and market a CAD package (hardware, software and training) for dealer resale. Wish me luck, guys and gals.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218, (301) 889-3890

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Bill O'Halloran, our 25th reunion committee chairman, announces that planning is well under-

way for our get-together on the weekend of June 9-11, 1989. Bill is also making plans for his wedding to Gretchen Mills next month. Regarding the former, he can use some help; please contact him at (617) 942-1203 (office) or (617) 944-5476 (home) to volunteer. Regarding the latter, he's doing fine; Gretchen and he make a lovely couple. Louise and I are looking forward to helping them celebrate their happiness. . . . **David Sheena** writes that he and Marlene now have four children—Jonathan (14), Deborah (10), Solomon (5), and Joshua (1)—and are living in Newton, Mass., "never being able to stray far from M.I.T." After earning a Course VI Ph.D. in 1969, he worked on eye movement instrumentation and research. In 1976, David and his brother Sami founded I.E.T. Labs, Inc., to design and manufacture precision test instruments. They now have a respectable line of products in impedance measurement and substitution. David says that he's fortunate to be able to enjoy doing some electrical engineering while running a business. . . . **Julian Adams** is busy in central Virginia as general manager of the area's "finest Chrysler-Plymouth dealership" and has gotten his part-time bonsai business off the ground (but not far, presumably). Julian was recently re-elected to a four-year term as at-large city councilman, runs four or five miles a day, and plays competitive (low A) squash.

Bill Young and his family visited Scandinavia and Holland last year; trip highlights included the fjords, Anne Frank House, and the new Delta Works along the Dutch North Sea. Son Danny celebrated his bar mitzvah, daughter Wendy will be going into her junior year at Choate, and wife Linda is a real estate agent. Bill racked up his eighth straight Number One Chemical Industry Analyst award, according to *Institutional Investor*, while continuing as a managing director at Drexel Burnham Lambert. . . . Chorus Data Systems of Nashua, N.H., announces that **Glenn Larson** joins them as vice-president, engineering, with responsibility for all engineering and product development activities. Previously, Glenn was with Cuneiform Systems, National Semiconductor, Digital Equipment Corp., and Sanders Associates. He earned a computer sciences master's degree from George Washington University after leaving M.I.T. Glen and wife reside in Amherst, N.H., with their two children. . . . Our news of classmates in this issue closes on a sad note. The Alumni Association received information that **Anthony Robinson** passed away on January 19. At the time of his death, he was a resident of Atlanta. No further details are available. Our sympathies to his family and friends.

I will be moving from TASC's McLean, Va., office to its office in Rosslyn, Va., within the next month, as director of the Systems and Policy Division. I'll be staying busy in the new position, but not too busy to read letters with news of classmates. Please send some.—**Joe Kasper**, Secretary, 3502 Idaho Ave. N.W., Washington, D.C. 20016

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Mary Coffey writes that after four years in San Francisco she has returned to the East Coast (and snow). Mary is living in Chapel Hill, N.C., and when she wrote was looking forward to warmer weather. She says that trips to the Boston areas are more enjoyable when it only takes two hours.

Steve Roth is another East Coast person—he lives in Manhattan with his wife Margaret and two daughters.

Joe Dyro, wife Betsy, their three children (Carolyn, Peter, and Laura), and Joe's mother spent a couple of weeks in Poland last summer. Joe volunteered to work with Project Hope doing bioengineering at the Pediatric Institute in Krakow. Joe says his Polish improved with the journey. He found the Poles a very warm, friendly, and sensitive people and reports that Poland is a beautiful country. Mamusia (dear mother in Polish) used her native tongue as an effective translator and interpreter. . . . **George Lee** is now working for Ashton-Tate as part of a team developing dBase for the Apple MacIntosh. . . . **Richard Nathan** was recently named president of Battelle's Project Management Division in Columbus, Ohio. This is one of Battelle's four operating divisions worldwide. The division has responsibility for large management and operations contracts. Richard has been with Battelle since 1970.

It's hard to believe, but Anne and I have been married for seven years now. I'm still managing computer and network security development work for Digital Equipment in Littleton. Anne left her post as associate dean for finance and administration at M.I.T.'s Sloan School last September and is now associate director of the Peabody Museum of Salem, one of America's oldest museums with collections in maritime history, ethnology, Asian export art, natural history, and archaeology. Anne loves the museum but is not crazy about the drive from Wellesley to Salem.—**Steve Lipner,** Secretary, 6 Midland Rd., Wellesley, MA 02181

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Last year, **John Dawson** was promoted to the rank of full professor of mathematics at Penn State's York Campus. He is also one of six co-editors of the "Collected Works of Kurt Godel." John's wife, Cheryl, '67, is assistant with the translation of Godel's long-obsolete German shorthand. . . . **Ed Tsoi** is a principal of Tsoi/Kobus and Associates Architects. Current projects involved office buildings in Cambridge near Lechmere Canal. Ed has been living in Arlington for 15 years, where he serves on the planning board. . . . Also practicing architecture is **Stephen Woolf**, in Amherst, Mass.

Some of what follows was delivered after an indeterminate delay, but it's still interesting. **William del Hagen** writes that after nine years as an aeronautical engineer, he became a lawyer, specializing in aviation and products liability cases. He is now a partner in Kirtland and Packard, a Los Angeles insurance defense firm. He has a son and a daughter, and a "compulsive interest in Ferrari automobiles." . . . **Peter Cukor** is president of Teknekron Transportation Systems in Berkeley, Calif., a systems engineering and consulting firm. . . . **Terry van der Werff** is in his sixth year as dean of science and engineering at Seattle University. Terry and his family spent six years in Africa in the late 1970s. His oldest daughter has just entered Seattle University, and his youngest has begun kindergarten. He says, "With five children, we are not without full days and empty pocketbooks." . . . **Donald Hess** has two daughters, Lura (10) and Johanna (7). His company, Amherst Systems, which he founded in 1975, has 60 employees now, and produces custom computer-based systems.—**Jeff Kenton**, Secretary, 7 Hill Top Rd., Weston, MA 02193

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Ron Norelli updates us on his activities since the formation of his management consulting firm, Ronald A. Norelli & Co., in May 1981. The firm is located in Charlotte, N.C., and specializes in strategic planning and management, generally for companies with $20-200 million in annual sales. In 1984 he hired an associate, and he now works with over 20 organizations nationwide. Many of his clients are companies in the midst of a crisis, with another segment being successful, growth-oriented firms that seek help in rethinking their priorities and strategic direction. During 1986 he worked almost exclusively in crisis situations. In May 1986 his firm was retained by the outside directors of a publicly held company, PCA International, and Ron was subsequently asked by the board to be interim president and start the restructuring process. The remainder of 1986 was hectic; by January his work had been completed, and a new management team officially took over at that time. Last year Ron's wife Nancy (Nancy Black, Wellesley '72, sister of Jim Black, M.I.T. '69) became a partner in the law firm of Kennedy Covington Lobdell & Hickman. Most important of all was the birth of their third child and second daughter, Lee Elizabeth, on May 1, 1986. "Luckily for us, Lee is a very happy and easy baby. Her smile helped me on the numerous evenings during the summer and early fall when I needed relief from lawyers (nothing personal!), bankers, creditors, and venture capitalists." Nancy and Ron extend an invitation to anyone visiting Charlotte.

Kiki and **Mike Rosenblum** offered the best possible excuse for missing our 20th reunion—at last report they were expecting the birth of their second child about the first week of June. . . . **Michael Coden** reports that Codenoll Technology Corp., the firm he started in 1980, is now the largest manufacturer of fiber optic LAN products in the world. Codenoll is located in Yonkers, and Michael lives in New York City, where he enjoys the cultural life. Codenoll has gone public and is looking for technical and sales/marketing personnel. . . . **Daniel Hester** serves as the entire physical science department in the Hiram, Maine, high school, where he teaches physics, chemistry and calculus. He has three lovely daughters—Jennifer, Lisa, and Laura, ages 14, 11, and 9.

John Rible was married two-and-a-half years ago, sold his home in Cambridge, and now lives in Santa Cruz, Calif., where his dream of working on a microprocessor has come true. John's work includes the instruction set, software design and testing, while his partner does the silicon layout and testing. Their product should be announced and available by the time these class notes appear. He lives in a group house with his wife and cat, as well as three other adults and three children (not theirs). His wife is an artist and writer who misses her native New England. John enjoys the California weather and restaurants and reports that the ice cream is almost as good as his memories of Steve's ice cream. John occasionally takes out the old surfboard, but his body is not as cooperative as it was 20 years ago.

Jeff Schoenwald was recently promoted to acting manager of the robotics and intelligent machines department of the Rockwell Science Center. According to Jeff, "acting manager is like 3.2 beer—you go to the bathroom a lot, but you never get drunk." . . . **Carl Kalinowski** is the New England/Mid-Atlantic regional sales manager for Unicad, Inc., a graphics software firm headquartered in Boulder, Colo. Carl lives and works in Somerset, N.J., and invites local alumni interested in skiing, catamarans, Tai Chi or an informal supper club to give him a call.—**Jim Swanson**, Secretary, 878 Hoffman Ter., Los Altos, CA 94022

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Having caught up with our backlog, we are now in dire need of more copy. . . . Our first item—and clearly our hero for the month—is a note from **Peter Jax** offering his services if we need some help with this column. Many thanks, Pete. Things are pretty much under control at present, but we certainly will take you up on your offer if we should find ourselves falling behind again. . . . The notable achievement of the month award goes to **Don Zagier** of the University of Maryland and the Max-Planck-Institut fur Mathematik (Bonn), who shared the 1987 Cole Price in Number Theory with two other people. This prize is awarded by the American Mathematical Society every five years for a notable research memoir in number theory that has appeared during the past five years. Don and his colleagues received the award for their contributions in the determination of an effective bound for the discriminants of all imaginary quadratic fields with a given class number, thereby solving a problem that goes back to Gauss.

Aviva Brecher recently made a presentation before the Boston Section of the IEEE, based on her experiences as a congressional fellow for Senator Paul Tsongas in 1984. She discussed the legislative process and the roles of, and opportunities for, technical professionals and technology assessments in policy decisions. Aviva is presently continuing to work in this area as an independent consultant. . . . **Mike Hammer** recently coauthored an article in *Sloan Management Review* on "The Changing Value of Communications Technology." The paper reports on how the emerging integration of computers and communications technology is expanding the realm of business opportunities. Mike heads Hammer and Co.

Richard Fox is vice-president, Vision Systems, Gould Inc., dealing with the use of cameras, electronics, and software to perform "visual" tasks in factories (such as counting, sorting, locating, and measuring). He lives with his wife Joy and 9-year-old daughter Karen in Orlando, Fla. . . . **Peter Bradish** reports that he has been a systems engineer for IBM for 18 years. . . . **William Ohm** has become a weekend farmer growing apples on 84 acres in southern New Hampshire. He offers 15 percent off to all M.I.T. alumni at the store ("Mountain Orchards," Mammoth Rd., NH Hwy 128, Pelham), so if you're out that way, be sure to stop in.

George Phillies writes, "I have now moved (myself and my lab) safely from an unhappy position at the University of Michigan to a happy position at WPI (Massachusetts' other institute) in scenic Worcester. Once again, I can visit M.I.T., at least on occasion." . . . **Richard Odessey** reports that he is presently associate professor of physiology at LSU Medical Center. He writes, "I have two wonderful kids, 6 and 10." He will be in Boston for a one-year sabbatical at Children's Hospital starting in June. . . . That once again cleans out the old In-box, so drop us a line on your latest news.—**Gail** and **Mike Marcus**, 8026 Cypress Grove Ln., Cabin John, MD 20818

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It's time to eat into the backlog of intriguing missives from the diaspora of '69. **Robert J. Randall** writes that he is back in his own business again—Randall Engineering. He specializes in greenhouse design and general structures. He became an "instant father" to two daughters last year by marrying their mother, Carol. . . . **Sandra L. Harris** is a systems analyst with Planning Research Corp. in McLean, Va. In May, Sandra married Mark Orton. The newlyweds and Sandra's sons, Andy Mathes (13) and Ben Mathes (10), are a family of fencers. Sandra writes, "I fence competitively in foil, epee, and sabre and am working currently to make sabre a recognized option for women at all levels." . . . **David L. Felten**, professor of neurobiology and anatomy at the University of Rochester School of Medicine, was recently honored with two awards: a Mellon Foundation Fellowship for research and teaching in neurosciences and an N.I.H. Merit Award from the National Institutes on Aging (an extended research award—five years plus five-year renewal) for studying aging mouse models of Parkinson's disease. . . . **Peter J. Hirz** and his wife Jane had their first child, Jonathan David, on December 7, 1986. Peter is still with the PC Division of I.B.M. in Boca Raton, Fla.

Hal R. Varian will soon become co-editor of *American Economic Review*, the most prestigious journal of the economics profession. . . . **Marvin E. Jernigan** and his wife Kim had their third child, Ethan, on Valentine's Day. Marvin is with Systems Design Engineering at the University of Waterloo and received a Distinguished Teacher award last year. . . . **Glenn Reierstad** and family have recently relocated to Alameda, in the San Francisco Bay area. Glenn writes that he would like to hear from other alumni in the area. . . . **Matthew M. Franckiewicz** asks me impertinently in a letter, "Is there enough room in Bow, N.H., for a street sign with the name of your road on it?" Answer: Yes, but it has to be stored in my barn to protect it against snow plows and the like. Mat writes, "After 13 years as an attorney and trial specialist with the National Labor Relations Board, I have left the N.I.R.B. to set up a practice as an arbitrator in Pittsburgh, Pa." . . . **Erdogan Kirian**, associate professor of chemical engineering at the University of Maine, is the 1986 recipient of the $15,000 Gottesman Research Chair for his contribution to pulp and paper science. His research is focused on the use of supercritical fluids for separating wood components in a novel pulping process. Erdogan was the first N.S.F. grant recipient for work to promote "high risk/high return" research. A native of Turkey, he was formerly employed by the Turkish pulp and paper industry, and served on the faculties of the Technical Institute of Instanbul and Bogazici University.

Actor **James Woods**, who has been nominated for an Oscar (for "Salvador") and an Emmy, was with our class till his junior year. The *Boston Herald* interviewed him recently: "M.I.T. didn't have much of a theater department, but its extracurricular opportunities were great. One professor there, the late Joseph Everingham, really left me with a love for the theater, that this was a very special profession. I've kept that always." . . . **Roger Chang** writes from Columbia, M.D., "After being elected to the Association of Old Crows board of directors as a regional director, I have been very involved in the professional and membership activities of this electronic warfare organization. I have also been a volunteer for the Baltimore Council on Equal Opportunity to encourage minority children to enter the engineering profession." . . . **Harry Goldmark** writes, "My family and I moved in June 1986 from Leominster, Mass., to Westchester County (Briarcliff Manor) in N.Y. to join my brother George M. Goldmark, '68, in orthopedic surgery practice in New York, N.Y. I have two sons—James (8) and Brian (6)—who are already computer crazy." . . . **Jeffrey M. Weissman** is a civil litigation attorney with the Miami law firm of Sparber, Shevin, Shapo, Heilbronner and Book, P.A., and was just elected to a three-year term as member of its board of directors. He writes, "My wife Linda (B.U. Sargent College '70) is extremely active in community charitable organizations. My two daughers, Karen (10) and Erica (7), keep us both busy and happy." . . . **Chris Ryan** writes, "I start the new year still with Geo-Con, Inc., the construction company I founded eight years ago. My big plan for the next year is to help rowing come to Pittsburgh. A group of us are mounting a major effort. Sandy Randall and his new wife Carol stopped to visit us over the holidays."—**Eugene Mallove**, 183 Woodhill-Hooksett Rd., Bow, NH 03301

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Karen Wattel Arenson has been promoted to editor in charge of the Sunday Business Section of the *New York Times*. Karen previously was assistant financial editor and has worked for the *Times* since 1978 after she left *Business Week*. She has a master's in public policy from Harvard and has taken further finance and accounting courses at Northwestern University's Graduate School of Management. . . . **Gregory K. Arenson** has moved to Proskauer, Rose, Goetz & Mendelsohn, a prominent mid-town firm where he is a partner in the Litigation Department. . . . **Howard Morris**, after receiving his bachelor's from the Sloan School and master's from the Civil Engineering Department, worked several years for the Massachusetts State government in the transportation area. Five years ago, he was in project management in Macomber Development Associates, a real estate development firm. He is now controller. He lives in Needham with his spouse Nancy and son Daniel. . . . **Hugh Masterman** joined MITRE Corp. as an associate department head for the development of the Display Technology Skill Center. He has two children, the oldest starting high school, and he is pursuing a doctorate in computer science at University of Lowell.

Arthur Davidson is spending the summer as visiting professor at the Technical University of Denmark. His spouse Janis and two children are with him. . . . **David Dobkin** has enhanced his paperweight collection while teaching at Princeton. He is actively involved in creating computer-generated images and movies and has one daughter. . . . **Robert Wilk** in 1986 became executive vice-president and co-founder of Triangle Portfolio Associates, an investment advisory firm specializing in equity management. He has two daughters.

Thomas Bales, Jr. is leaving the engineering division of Theratek International Inc., which is a start-up funded by Cordis Corp. to develop a rotational catheter device for resolving atherosclerotic deposits in arteries. . . . **David McIlwain** continues his work at the Department of Justice in the Land and Natural Resources Division. His spouse Ann and he have a two-year-boy. . . . **Fred Campling** is an assistant crown attorney in Hamilton, Ontario, prosecuting a variety of criminal charges. He has two children and looks forward to skiing in Vermont.

On a personal note, our law firm merged several years ago and we are presently renovating the 11th floor of this bank building to accommodate the firm's needs. I am specializing in litigation, both civil and criminal, and business law. My spouse Maggie has continued to be active as a lawyer but also is involved in commercial and residential real estate sales and development. I fulfilled a dream of mine by designing, managing and finally opening a bar and grill which has, in two weeks since it has opened, had a surprising success. It is modeled after the large city bar and grills, and I have enjoyed the continuing unique experiences.—**Robert Vegeler**, Secretary, Beers, Mallers, Backs, Salin and Larmore, 2200 Ft. Wayne National Bank Bldg., Ft. Wayne, IN 46802

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Steven E. Morrow was declared a Certified Purchasing Manager by the National Association of Purchasing Management. He works at Puget Sound Power and Light; he was information systems consultant for four years and is now manager of purchasing. He's also active in REACT, Kiwanis, and United Methodist activities. . . . **Paul Lewis** (formerly Greenfeld) writes, "I was married on May 18, 1986, to Ellen Resnick. My wife is an executive recruiter for investment bankers at E.J. Lance and Co. I am a vice-president in the National Positioning Group at Chase Manhattan Bank, where I plan acquisitions of smaller banks throughout the country. We live in Manhattan but plan to take the big plunge into suburbia (Westchester) soon. . . . **Alfred I. Anderson III** writes that he has been working at the May Clinic for the past 15 years and is now manager of the Personal and Research Computing Systems Unit. Al frequently wonders what the East Campus crew is doing. . . . **Charles F. Lanzillo, Jr.**, practices ophthalmology in Connecticut. He asks, "Where are **Rick Finocchi**, **Ray Huey**, **Walt Miller**, and Don Jujimoto, '69?" . . . I have managed to put off my mid-life crisis by buying a 1970 Porsche 911 Targa.—**R. Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

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An average-sized report this month, as I face my 36th birthday and contemplate the marvels of parenthood. . . . **Kevin Lloyd** notes the birth of his second son, Brian, this past November. Brian joins Andrew (3) in the Lloyd household. When not producing sons, Kevin is treasurer of Atlantic Fuels Marketing Corp. . . . **Jeff Seltzer** practices cardiology in eastern Connecticut. His first child,

Gregory, was born in March. . . . **Christos Demetriou** is managing director of a company on Cyprus, refining vegetable oils and producing margarine products. He has two sons. . . . **Darryl Dawson** is a member of the executive committee of the M.I.T. Enterprise Forum of Chicago. He serves as management information systems director for Sonicraft, Inc., after receiving an M.B.A. in 1985 from Illinois Tech in technology management.

Steven Warsof is now board-certified in maternal fetal medicine in Norfolk, but "could use some help from a course II major to fix (his) sump pump." . . . **Sandra Lehner** and husband Carl had a daughter, Jessica, in January—their second child. . . . **Mitch Reff** and wife Miyo have two boys, Jeremy (4) and Brian (1). Mitch is an assistant director with the molecular genetics department at S.K.F. . . . My own two boys are busy this past year. Eric (13) has been taking skiing and tennis lessons through his school; he will enter eighth grade this fall standing a good three inches taller than his father by that time. Jr. (6), who has been reading since age 2, is a dinosaur buff when not playing with his brother's computer.—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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Randy L. Garrett works for Science Applications in West Palm Beach, Fla., and hopes to complete his Ph.D. in computer engineering at a local state university next year. He and his wife Rene celebrated their fourth wedding anniversary in March. . . . **Ben Hauptman** writes, "My wife Naomi and I now have two children, Ariel (4) and Joshua (2). I was recently admitted to equity partnership at Lowe, Price, LeBlanc, Becker and Shur, where I practice patent law." Ben adds that he wouldn't mind hearing from Chi Phis, "wherever situated." . . . Congratulations are in order for **Wendy Landman** and **Joel Weissman** on the birth of Gideon Landman Weissman on August 12, 1986. They say they are having a great time. . . . That's it for now. Keep those cards and letters coming.—**Jennifer Gordon**, Secretary, c/o Pennie and Edmonds, 1144 Ave. of the Americas, New York, NY 10036, or 18 Montgomery Pl., Brooklyn, NY 11215

76

Paul Fryd has formed Ariel Enterprises, a company to develop and market products for the disabled. . . . **Todd Kushner** received his Ph.D. in computer sciences at the University of Maryland in 1982. He is now working as associate staff in the Center for Automation Research at UM on the Autonomous Land Vehicle Project funded by DARPA as part of the Strategic Computing Program. His group is working closely with Martin Marietta Denver Aerospace on the project. . . . **Clyde Mitchell** "recently left the practice of corporate law (Shearman & Sterling) for an associate position at the First Boston Corp. with the Reorganization Group, which advises financially troubled companies and creditors with problem loans."

James Harrison has been working as an environmental scientist in the Water Division of the U.S. Environmental Protection Agency's regional office in Atlanta for the past seven-and-a-half years. He is also involved in a curriculum development project for high school level environmental courses. . . . **John Wacker** is currently at the Scripps Institution of Oceanography studying diamonds. He was planning to take a permanent position in May at Battelle Pacific Northwest Laboratories in the Analytical Chemistry Section. . . . **Leon Sweer** reports that he has a son, Ryan Eric Sweer, born November 26, 1986.

I finally have news, 11 years later, of **Susan Thomas**: "I worked for a whirlwind seven years in the semiconductor industry, including many years as a self-employed consultant. Then, in 1983, I entered medical school at Yale University. I graduate in May and will begin residency training in the field of family practice in Hartford, Conn., a new up-and-coming program that emphasizes disase prevention and community participation in health care. I have traveled extensively in Asia, Europe, and the U.S.S.R., but my current focus is on Latin America. There is so much to learn!"

From the Sunday *New York Times* social pages, we have news of **Paul Turgeon**. Paul has married Marion Irwin, an alumna of Smith. Paul is working in the professional services information department at Morgan Stanley and Co. Our congrats!

Insofar as your secretary is concerned, the futures markets continue to have both tidal wave type trends and some fairly large gyrations. Among the more exciting (and terrifying) areas have been silver, foreign exchange, bonds, stock index futures, and coffee. This is not an exhuastive list! As I write this, my daughter Shana is approaching closely the one-year mark. I cannot believe that a year has passed so rapidly. But my calendar tells me it is indeed so. On the business front, the above price swings have generated a certain amount of business, as fear induces customers to hedge their price on rate risks, a service we provide. However, human nature is a most peculiar thing. It is still difficult to have first-time hedgers use the futures markets to reduce price risk. However, once they do use it, they learn at a very rapid rate and marvel, in short order, how they managed to live without this. The transformation is interesting to observe.

Please write. We need the news.—**Arthur J. Carp**, Secretary, Stalco Futures, Inc., 225 West 34th St., S. 1705, New York, NY 10122, (212) 736-1960

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Paul Fallon passed on the sad news that **John McAleese** died last summer after a long fight with cancer. His daughter Katie was a great joy to him during his last years. John was well remembered at a Phi Delta Theta reunion last August, which all the '77 Phi Delta Theta members attended.

Paul was gracious enough to write a long letter including news of other classmates as well. . . . **Ed Curtis** has been with Exxon in New Orleans for six years. He and his wife, Daphne Forbes, have a 2-year-old daughter. . . . **Joe D'Amore** is working on an interferon project at Hoffman-Larouche in New Jersey. He and his wife Karen are expecting that their adoptive daughter will have arrived early this year. . . . **Ed Hammer** "(also known as Mr. Potato Ed)" is with Ore-Ida in Boise, Idaho. Ed and his wife Kathy were expecting a child soon. . . . **Dave Lu** is doing cardiac research at the N.I.H. since finishing at Yale Medical School. Dave and his wife have a daughter.

Bill Brown is an attorney for a New York law firm, whose many names Paul apologized for not writing down. Bill and his wife Amy were expecting a baby in 1986 and buying a Brooklyn brownstone. . . . **Bill Sweet** "takes the Dad-stakes" with his three sons—Billy, Ethan, and Colin. Bill just completed a stint teaching chemistry at West Point and is now on a tour of duty in West Germany. . . . **Dave Passmore** and Susan "showed up in the hottest car of the bunch, of course. From what I can understand, he's the high-tech whiz of Washington D.C., at the very least." . . . As for himself, **Paul (shorty) Fallon** and Lisa Dobberteen recently moved back to the Boston area. Paul is an architect at Shepley, Bulfinch, Richardson and Abbott, and is designing a new hospital/medical school for Dartmouth University. Lisa began her internship in pediatrics and child psychiatry at Tufts/N.E. last June. Paul and Lisa have just moved into a two-family house in Somerville that "offers me endless weekend of fix-up projects which I enjoy." Thanks for the letter, Paul.

Julie Malakie recently returned from a five-month trip to India, one of her favorite countries. This spring, Julie began a master's degree in photojournalism at Syracuse University, "a departure from my economics/business background, but I still read the *Wall Street Journal* for fun!" . . . **Sue Ellen Stewart** completed graduate school at Brandeis in January 1986 and is now working as a postdoctoral fellow at Yale. Sue is pursuing research in yeast genetics and "adjusting to life in New Haven." . . . **Michael Jesse Chonoles** is now a software technology engineer for G.E., living the homeowner's life in Malvern, Pa.

Alberto Sadun is still enjoying teaching astronomy at the Agnes Scott Womens College in Atlanta, Ga., and doing research in astrophysics as director of Bradley Observatory. . . . **Brian Hughes** founded Tel-Optik, Ltd. in 1984, and the company has just signed a letter of intent with STC for a $350 million transatlantic fiber optic cable, to be operational in 1989. Tel-Optik has been conditionally sold to NYNEX, subject to regulatory approval. Brian's motto in this seems to be "Avanti Sub Maris" or "onward and downward." Brian and his wife, Lisa Martinez '76, had their first son, Richard, last year. . . . **Earl Bunker** is getting ready to take a one-year leave of absence from Digital and is "going to San Diego to enjoy the California life-style for awhile."

Juian West recently moved to Lan-Tel, where he is in charge of software engineering. Julian says he is still in the telephone switching business, "just a different location." . . . **Andre Au** quit his job in Boston in fall 1985 and moved to California. He began working in the San Francisco Bay area in January 1986 and is now a project manager at the Lincoln Property Co. Andre bought a house in Cupertino in November and is enjoying the warm, sunny weather. Andre's wife was expecting their second child in June, and Andre is glad they gambled and moved cross-country. . . . **Steve Aaronson** has had his own computer consulting and software development business for the last two years.

Steven Grossman has been at Advanced Micro Devices in Sunnyvale, Calif., as marketing manager for Field Programmable Logic for the last year or so and was looking forward to seeing folks at our 10th reunion. . . . **Ramiro Garron** moved to Austria for several years to do pharmaceutical plant design and construction for Daniel Intl. "Driving to work at 100 mph on the freeways of Bavaria and Tirol is a daily routine." Ramiro lives in a house on a ski slope, and classmates are welcome to drop by. . . . **Stewart Silling**, assistant professor of engineering at Brown University, has received an NSF award, to continue research in phase transitions and deformation of elastic solids.

Michael Lesh is now a cardiology fellow in electrophysiology at University of Pennsylvania Hospital. Michael is doing research involving computer modeling of abnormal cardiac rhythms. . . . **Joel Lederman** recently joined Schaeffer Magnetics in Chatsworth, Calif., as a project engineer. Schaeffer produces motors and actuators for satellites.—**Barbara Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

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Gordon Haff has returned to the Boston area (as all alumni seem to do eventually) with the M.B.A. he received from Cornell University's Johnson Graduate School of Management in June 1986. He works in product marketing for Data General in Westborough. . . . Our man in Argentina, **Martin Aboitiz**, writes, "**Jeff Dugal** ran into **Mark De Lemos** in Alaska? Well, I ran into **Ron Gilman** and **Brenda Pomerance** at the Buenos Aires airport. A memorable encounter, as my wife and friends can attest to." . . . Speaking of Alaska, **Bruce Lubow** writes of his adventures,

"My wife Dana and I have spent the last year on leave of absence from Digital Equipment Corp., where I had been managing a decision support systems group. We spent the majority of our leave in Alaska and the Yukon Territory of Canada. We hiked extensively in the Brooks Range, canoed the Snake and Peel Rivers in the Yukon, hiked and cross-country skied in Wrangell-St. Elias National Park, visited many other parts of Alaska, and lived for several months during the winter in a primitive log cabin in the Alaskan bush where we were visited by Mark Neiman, '77, who flew up from Dayton, Ohio. We also spent a couple of months in the Rockies hiking, cross-country skiing, and downhill skiing. We had a fantastic year, but for now its back to DEC. We are, however, returning to Alaska for three weeks this summer." . . . **Kevin Wade** and his wife, Sheila Luster, '78, write from Goldsboro, N.C., "Kevin is still flying with the Air Force (F-4), while Sheila is with a civilian civil engineering firm in downtown Goldsboro. We expect to be in the North Carolina area until 1989. Visitors are welcome." . . . Robert and I will be heading up to M.I.T. in early June for his 10th reunion (he graduated in 1976 but had entered M.I.T. with the class of '77). I don't expect to see too many other '79ers while we're there but I'll do my best to dig up some dirt about somebody (the dirtier, the better!). Until next month—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

80

Greetings once again from beautiful downtown Cambridge, Mass. For those of you who haven't been back for a while, the old place has come a long way since September 1976—and even since June 1980.

Darryl Fraser writes that after he received his M.B.A. from U.C.L.A. in 1984, he transferred from T.R.W.'s Propulsion Engineering Department to become a corporate management intern for two years. Upon completing that, he became manager of planning for T.R.W.'s Space and Technology Group; he coordinated the development of their strategic plan. His wife, Leslye Miller Fraser, '78, and he became proud parents on December 3, 1986, with the birth of their daughter, Brittney Nicole. . . . **Charles Wilson** is keeping busy in sunny California with interesting work at Lockheed, endless work on his recently-purchased 28-year-old house, and enjoyable work on the pool in the backyard. His wife of three years, Laurie McGray Wilson (Simmons '79), still want to return to Boston, however.

Christopher Moss is consulting for Arthur Andersen and Co. in Pittsburgh. His wife Mira (Wellesley '81), to whom he's been married for six years, is finishing her Ph.D. in psychology at the University of Pittsburgh. . . . **Jim Jackson** writes that he and his wife adopted a 3-day-old baby girl early in 1986, and that his wife was seven and a half months pregnant as of this March. Jim works as a principal engineer at Digital Equipment Corp. in Shrewsbury, Mass., in the Storage Architecture Group. . . . Speaking of Digital, your secretary has changed jobs again: this time I decided to get a real one—no more consulting for me!—in a corporate marketing group at Digital in Concord, Mass.—**Kate Mulroney**, Secretary, 256 Hampshire St., #3, Cambridge, MA 02139

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Jim Madsen, Santa Barbara, Calif., is a product manager at Kilovac for a large product line where he coordinates marketing and manufacturing. In addition to his work activities, Jim, his wife Azmina, and son James have been traveling. Recently, they spent three weeks in Italy, Germany, and Holland. Jim returns to student status this fall when he begins work on his M.B.A. at the Stanford Business School. . . . **Susan Barr** sends a beautiful postcard of San Francisco with news of her young daughter Gwendolyn who was born on December 30, 1986. According to Susan, she's a fine example of a baby, complete with chipmunk cheeks and a gummy smile. Congratulations to Susan and her husband John, '79. . . . **Jeff Oehler** has had a change of career since I last saw him in Cincinnati about five years ago. After a couple of years at Procter and Gamble, Jeff and his wife, Mary Britt Oehler, '82, decided to go to medical school. They are both completing their third years at Ohio State University.

Dave Slobodin recently received his Ph.D. in electrical engineering from Princeton University. Since graduation, he's been living in Waltham, Mass., where he works for Polaroid developing thin-film solar cells. . . . **David Fischi** is also in the Boston area. He's currently working at Lincoln Labs after having completed a program in space research at M.I.T. . . . **Kumkum Mathur Dilwali** is currently a consultant with Arthur D. Little specializing in risk assessment and consequence analysis. She's juggling motherhood (with her year-old son) and her career thanks to the support of her husband and family. She says that the "all-nighters" remind her of ChemE courses of years ago.

Connie Bair-Thompson married Randy Thompson (University of Texas at Austin, 1981) in August 1984. She's enjoying married life and is now working as a project engineer in factory automation control systems for Process Control Industries, Taunton, Mass. They live in rural Wrentham, Mass., where they are "happy but mortgage poor." . . . Another Boston-area resident, **Perry Justesen**, writes to say that his family (wife Darlene, two sons Kristjan, age 4, and Nicholas, age 2, and newborn baby) have finally settled down in a new house after five years of constant moving. . . . **Polly Grunfeld Sack** is very busy working in the Boston office of a major Wall Street law firm since graduating from Stanford Law School. She spends free time dancing and working with local humane societies and animal shelters. . . . I ran into **Johan Magnusson** about a month ago in the supermarket. He's working on his M.B.A. at Harvard.

Eric Whitaker is an air traffic controller at Meadows Field airport in Bakersfield, Calif. . . . **George Dowd** has settled in the New York area. His daughter Claire was born on December 12, 1986. George has started a new business—Intelligent Management Technology Inc.—a small firm specializing in small business computer systems and investment programming. Good luck! . . . **Dave Nelson** married Ulrike Heizmann of Freiburg, West Germany, on June 14, 1986. Dave's the laboratory technical director at Acoustic Systems Acoustical Research Facility in Austin, Tex.

Harvey Woehlck, M.D., has switched from surgery to anesthesia, claiming that he now has more time to spend with his family. He says that since their was little snow in Madison, Wis., this year, he and his wife Heidi have taken up karate. . . . **George Lesieutre** and his wife Annie are pleased to announce the birth of their first child, John "Jack" Daniel. George is enjoying work at SPARTA, a small employee-owned business in Laguna Hills, Calif. "Only" a dissertation remains between George and a Ph.D. in mechanical/aerospace engineering at University of California Los Angeles. . . . **John Schiffhauer** has been living in New York City for the past two years, where he has been working for the patent litigation firm of Morgan and Finnegan. John's busy working for some big name clients defending them on big time issues!

I had drinks with **Julie Neuringer** when I was in Dallas on business. She's enjoying her residency in internal medicine. Julie says that **Nora Fong**, also a resident in Dallas, is doing well. . . . After several years of management consulting at Bain & Co. in Boston, I have moved into real estate. I am now with The Krupp Companies as an assistant vice-president of acquisitions and enjoying it very much. That's all the news for now. Please continue to send letters and postcards.—**Lynn Radlauer Lubell**, Secretary, 216 Beacon St., Boston, MA 02116

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This spring will mark our five-year reunion, the first of many reunions for our class. Dates for our reunion weekend have been set for Thursday, June 2, through Sunday, June 5, 1988. I hope all of us will be able to attend. It would be great to see everyone from our class again. There will be accomodations on campus as well as off campus. If you are talking to other classmates, be sure to spread the word.

Activities for the weekend are completely up to us. If there is something you think we would all enjoy doing, drop me a note or let one of the other class officers know. Suggestions thus far include an evening at the Pops, clambake, Newport mansion dance, and a drink-off with the class of '23. Keep in mind that all class members share the expense in that each is assessed a fee for the entire weekend's activities. That fee is determined by our own extravagance.

Jonathan Huber has moved to 2360 Selby, Los Angeles, CA 90064. Jon did not say what he is doing. . . . **William Benack** is finally married after playing the bachelor's life for 26 years. He married **Keri Yura** in August 1986. They said it was a simple ceremony (only invited 1,500 of their closest friends). Good luck to you both. . . . **Christopher Elnicki** has decided to come home. That's right, he is coming home from his three-year adventure on the West Coast to work for an architectural firm in York, Pa.

As for myself, I continue to play around in New York. I am getting ready to enjoy the summer weather and prepare for our reunion. I am looking forward to seeing everyone next year.—**John E. De Rubeis**, Secretary, 14 Charles Ave., Port Washington, NY 11050

84

Hi gang! I hope all is going well with you. Here's how your classmates are doing. **Larry Rosen** writes, "Some big news for our class has occurred. On December 27, 1986, **Ogden "Hoose" Jones** and **Jennifer Lin** were married in Storrs, Conn. Both Og and Jennifer were members of Random Hall, and there were quite a few Randoms present. In attendance were Og's brother Mike, Jennifer's brother David, Sue and Jesus Velasquez, **Michelle Bagdis**, **Joe "Comedy Jokes" Klein** accompanied by the dazzling **Lisa Rosoff**, **Rick Kane**, **Liz Anderson**, **Mike Roberts** and **Nancy Davis**, **Hari Das**, **Bill "Tower" Hoston**, Deena and Keith Taylor, '80, **Pete Ahumada**, **Andrea Rosca Carpentieri**, and me, **Larry Paris Rosen**. This may have been the biggest Random reunion thus far. Og and Jennifer are living in Seattle where he works at Boeing and she at the University of Washington. Other M.I.T. Randoms in Seattle include **Charles Benesh** with wife Teri and son Andrew, the long-lost **Kermit Kohn**, and me. I am currently working at Spectra Technology, doing modeling of plasma physics. I hope this will inspire other M.I.T. Randoms and students of all classes, races, and species to write and let us know what's new!

Marlene Downs is living in Homedale, N.J., (close to the shore) and working for Bell Labs. She says she met **Darrin Taylor** in the Bell Labs dining room in June 1986, and is back at M.I.T. now, getting his Ph.D. **Sheena Murphy** is at Cornell studying physics. During a trip to San Francisco, Marlene saw **Ira Leventhal**, **Louis Vintro**, who is at Stanford studying applied physics, and **Scott Globus**, who is a free-lance photographer in San Francisco. . . . **Phil Gleckman** is at the University of Chicago studying physics. . . . Scott Elias ('83) is in graduate school at Berkeley and is engaged to Marlene. . . . **Jon Ellman** is at Harvard studying Chemistry. He lived near **Richard Williamson** at Harvard. . . . **Albert Perez** is in the

Air Force getting ready to be stationed, he never called to tell Marlene where. . . . **Arman Begonia** and **Jackie Griggs** had a BBQ with Marlene in a snowstorm, they're both at Bell Labs. Marlene had only one wedding to mention, **Beverly Yates** married John Gonzales ('83) in June 1986.

I also spoke to **Mark Farley** a few months ago. He has changed jobs, from Tandem to Raychem in Menlo Park, Calif. He lives with Chris Schneider ('83) in Mountain View. He keeps busy playing a lot of volleyball and soccer.

Other news from Delt House: **Todd Bayer** is living in Redondo Beach, Calif. working for the Air Force Space Division. . . . **Jim Ellard** finally broke up with his girlfriend of two years and is back on the hunt. He lives with Glen Grandea (Reggie) ('85), and bought a condo in Salem. They both work for New England Biolabs. Jim's work requires him to do a lot of traveling.

Ed Monuki is in San Diego at medical school and loves it. . . . **Kevin Mayer** bought a new motorcycle and is going for a Master's in electrical engineering from San Diego State University. . . . **Darryl Palmer** is getting an M.D./Ph.D. in San Diego, along with Peaches, a.k.a. Alessandra Pecci ('85) and **Charlie Lemoli**. . . . **Carolina Leonard** is working in D.C. for a small systems engineering company and having a wonderful time. . . . Annabelle Kim ('86) and **Scott Weingaertner** are engaged. . . . **Bob Abramson** is working for Hughes Aircraft and living in Manhattan Beach, Calif. He is thinking about running for president in 1988, so if you're reading this Donna Rice. . . .

Patrick Gerdes received his M.S. from Stanford in aero/astro, and has been working for Hughes. He and **Greg Burgess** both work in the systems lab. . . . **Mark DeCew** spent last summer in Loch Ness looking for the famous monster with a group from M.I.T. including Dr. Bob Rhines, using Doc Edgerton's photography equipment. Now he's out here in California at University of Southern California's famous film school, getting his M.F.A. in film production. . . . **Eric Brandt** is starting at Harvard Business School in the fall for his M.B.A. . . . **Jim Deasy** is working in construction in San Francisco. . . . **Steve Smith** is moving back to Boston. . . . **Brian Manion** and Lizzie are expecting a baby in May or June. Brian is in a Ph.D. program at New York University Medical School, and Lizzie is pursuing a Law degree, finishing up this spring. They just moved to a large apartment in the Bronx (family-sized)! . . . An anonymous source revealed that **Tim Kneale** moved to Texas with his fiancee.

Nancy DeFeo is working at JPL in Pasadena, Calif. with Jim Hutchinson ('85). . . . **Laura Lesniewski** works for the Woo and Williams architectural firm in Cambridge, and **Larry McKenna** is a graduate student at M.I.T.

Steven Untersee began training with the Peace Corps in February, 1987, in preparation for his two-year assignment in Botswana. As a Peace Corps volunteer, Untersee will work as a teacher of general sciences at the junior secondary level. . . . **Richard Babboni** says he has been playing in Southern California for over a year now, and will be in **Ron Bujarski**'s wedding party in June 1987. . . . **Jim Adkisson** is married to Jennifer Harrison (Wellesley '85) and is at Stanford working toward a Ph.D. in electrical engineering. . . . **Russell Brand** is happily building strange computer input devices and breaking into computers while working toward his M.S. in computer science at the University of California at Berkeley.

Geoffrey Campbell is a graduate student at University of California Santa Barbara in their new department of material sciences. He received his M.S. at Berkeley, and he and his professor came to U.C.S.B., where he is now working toward his Ph.D. . . . **Rich Rho** is a medical student at University of Southern California and says hi to everyone. He says he is doing well. Others in Southern California are **Ann Chen**, and **Aaron Judkiewicz**. . . . **Ik Song** works on robotics in southern California and was in Boston a while ago on a business trip.

Barbara Poggiali writes that she was married to David Keller ('81) in September 1986, in Italy. Many classmates, mostly number sixers, attended. She completed her Ph.D. at M.I.T. in April 1987 in materials systems analysis. She's now a post-doc, but will be moving in July to Milano, Italy, where she will start a job with McKinsey. She hopes to become involved with the M.I.T. Alumni Club in Milan. (I have her Italy address if anyone needs it.)

John Holcomb is currently assigned as the assistant missile officer aboard U.S.S. New Jersey (BB62), homeported in Long Beach, Calif. He will be marrying Miss Monica Sypien in Fullerton, Calif., on August 2, 1987. Mr. **Albert C. Bashawaty** will be his best man. Miss Sypien is a graduate of California State Fullerton, and is employed by T.W.A.

That's it for this issue. Thanks for all the news, and keep it coming!—**Diane M. Peterson**, President, 350 Palos Verdes Blvd., Apt. 20, Redondo Beach, CA 90277-6329; (213) 375-4991

85

I am sad to report that **David M. Yanni**, a course 1 graduate, passed away last February 10. At the time of his death David was employed by the Institute for Defense Analysis in Alexandria, Va. He was planning to enter Stanford in the fall to pursue a Ph.D. in aeronautical engineering. I do have his parents address, please contact me if you would like it.

On the lighter side, **Friedrich Geck** returned from five weeks in Europe during the summer of '86 (are my sources slow or what?) and is now working for Bell Labs in New Jersey. . . . **Lisa Goldfarb** is a third year medical student at the Columbia University College of Physicians and Surgeons. She has been keeping in touch with **Sara Sprung** in New York City.

Gary Wyetzner received his Master's in electrical engineering from University of Southern California at the end of '86 and is now working with a bunch of geniuses at The Aerospace Co. in Los Angeles. . . . **Noelle Merritt** is on the opposite coast in Boston. She works as a systems engineer for I.B.M. and is living on Marlborough St.—"the center of the Universe."

We also have a couple of weddings and an engagement! You've heard that weddings lead to more weddings (with different couples of course!), well there just might be something to that! Jeffrey Winner and I will be married on September 5 in lovely Sunnyvale, Calif. Friends of **Deborah Meinholz** beware of cupid's arrow! In July Deb married John Rice ('84) and they now live in Michigan.

Au revoir! I'll be thinking up next month's column as I'm honeymooning in Egypt, Turkey, and Paris!—**Stephanie Scheidler**, Secretary, 1026 Live Oak Dr., Santa Clara, CA 95051; (408) 985-6827

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Newsflash. Dateline: 15 May 1987. Somewhere between Washington, D.C., and Los Angeles at 35,000 feet. I didn't receive very much correspondence this month, so I'll have to wing it. **Fred Johnsson** sent me a postcard from Sweden where he's taking a couple of plant trips. He's also visiting a relative at Stockholm's Law School and having wild times. . . . The only other person to write in was **Mary Ystueta**. She was helping out with the Alumni Fund drive and got a chance to talk to some people. . . . **Yashi Ahmed** is not at Stony Brook Medical School but at Duke, where she is thoroughly enjoying herself. . . . **Cary Ching** is working for IBM in New York and commutes home to New Jersey on the weekends. . . . **Reece Corlandi** is in Huntsville, Ala., working for Rexham in the area of structures. . . . **Sherry Solden** is at Intel in Santa Clara, Calif. . . . **Mary Manger** is back at M.I.T. for grad school. . . . **Steve Brandwein** is attending Northwestern University's medical school.

Angela Lowry married Otis Bricker last July and they are now living in Somerville. . . . **Alix Klickoff** and Les Watts, '83, had a boy in September, Michael Alexander. Alix will start medical school in the fall. . . . **Buzz Moschetti** is employed by Salomon Brothers in New York City and doing extremely well. . . . **Judy Ko** married Fred Wu, '85. . . . **Beth Dernbach** is working at American Systems, and **Michelle Lin** is in her first year of University of Pennsylvania Medical School. Mary also spent a week in Philadelphia with **Sharon Israel**, **Cheryl Ingram**, **Toi Beveridge**, **Rose Joseph**, **Alka Jain**, **John Villani**, and **Yong Mi Choi**.

Craig Poole is working as a system engineer for GTE, Tactical Systems Division, in Needham, MA. While serving as an educational counselor for M.I.T., Craig also helped out as assistant coach for the M.I.T. men's basketball team. . . . **Doug Smith** married Coleen Barry, '87, on May 30, 1987. . . . **Noel Zamot** is currently pursuing a master's at University of Michigan. I suppose he's probably finished by now because he is supposed to start flight school this month at Mather AFB in Sacramento, Calif.

Well, that's all the written material I received, so I'll resort to my packet sent by *Tech Review*. . . . **Mike de Vegvar** is a member of the technical staff of the MITRE Corp. in Bedford, Mass. . . . **Linda van Duyne** is a co-op master's student with IBM. . . . **Victor Abrash** is attending Churchill College in Cambridge, England. . . . **Jay Adams** is employed by Hewlett-Packard at Fort Collins, Colo. . . . **Virginia Agresti** is working for GM in Troy, Mich.

Dave Altschuler is attending Harvard Medical School. . . . **Juan Alvarez** is a grad student at University of California at San Francisco. . . . Both **Dave** and **Eric Anderson** decided to continue their educations at M.I.T. . . . **Stephen Andes** works for GE in Wilmington, Mass. . . . **Robert Anello** is at SUNY, Stony Brook, and **Karen Annis** is employed by Foster Miller, Inc., in Waltham, Mass. . . . **Dale Archer** and **Jeff Arenberg** are back at the 'Tute. . . . **Allan Armstrong** is with HP in Santa Rosa, Calif. So much for the As. We'll continue the alphabet next month.

On to the gossip. I ran into **Gret Harrison** in the Washington, D.C., Dulles Airport (sorry, PKT but if you're tired of seeing Greg's name, write me and let me know what you're doing). He was finishing up a week of acquisition management class at Fort Belvoir, Va. . . . A couple of weeks ago, three of the four Ellens got together in D.C. . . . **Anne Fricker**, **Ellen Epstein**, and **Karen Wohl** crashed at **Mark Emineth** and **Dan Pyne**'s apartment. Two weeks later I had a party with **Sonya Sakai**, and Ellen and Anne came down from San Francisco for it. Ellen will start work next month at Merrill Lynch in New York City, and Anne is employed by Clorex in Pleasanton, Calif. Diane Peterson, '84, showed up, too. She's working for TRW here in Torrance, Calif. Ellen took off to Las Vegas for a couple of days to visit Jim Danna, '84. We went to Tijiuana when she came back and ended up sampling the margarita population down there.

While I was in D.C., I ran into Bob Maya, '85. Bob is a lieutenant in the air force stationed at the Astronautics Lab at Edwards AFB, Calif. I was at the Astronautics Lab earlier this week, and I ran into John Phillips, '85. He is also in the air force working for the Foreign Technology Division at Wright-Paterson AFB, Ohio. John Gibson, '83, called me about a week ago. He's still in the navy and is getting ready to move to South Carolina. Dave Shumway, '83, married Peggy Pescatore, '83, and Cliff Olson, '83, will be coming out to attend the Naval Postgraduate School in Monterey, Calif.

That's all I have for this month. Remember, drinking wine, beer, and other alcoholic beverages during pregnancy can cause birth defects. —**Mary E. Cox**, Secretary, SD/CLTPC, P.O. Box 92960, LA AFS, Los Angeles, CA 90009-2960

COURSE NEWS

I CIVIL ENGINEERING

Two promotions were effective July 1 on the faculty at M.I.T.: **Yosef Sheffi,** Ph.D.'78, is now full professor, and **Lorna J. Gibson** is associate professor. Sheffi heads the Transportation Systems Group and the newly-formed program in engineering systems and computation; he's a specialist in network analysis. Gibson, who studied in Canada and England, came to M.I.T. from the University of British Columbia in 1984 to work in mechanics and applications of cellular materials for construction.

To **Henry D. Tomlinson,** S.M.'55, the 1987 Engineer of the Year Award from the Northeast Florida Chapter of the Florida Engineering Society. Tomlinson is senior vice-president of C. C. Vargas and Associates, Ltd., consulting engineers, Jacksonville; he's had more than 35 years' experience in environmental engineering, including work as project engineer or principal investigator on projects in 22 states.

To **Chiang C. Mei,** professor of civil engineering at M.I.T., the 1986 Rosenstiel Award in Oceanographic Science from the University of Miami's Rosenstiel School of Marine and Atmospheric Science. Mei was cited for contributions on the dynamics of ocean surface waves; "his work is characterized by a deep understanding of physical processes combined with a complete mastery of the associated analytical techniques," said the citation. At M.I.T. since 1965, Mei holds degrees from Stanford and Caltech.

Erik H. Vanmarcke, Ph.D.'70, now professor of civil engineering and operations research at Princeton, told Ann Waldron of the *Princeton Weekly Bulletin* early this year that earthquakes remain "unpredictable." All you can be sure of, said Vanmarcke, is that they'll continue to happen. "And no matter how carefully you build, there is always some risk of failure," he said. The real problem is to anticipate the kind of ground motion that buildings in an earthquake zone may experience, and Vanmarcke has National Science Foundation support for a Princeton research program on this question.

Alonso E. Rhenals, C.E.'75, reports, "Since December 1980, I have been working for the Analytic Sciences Corp. (TASC) in Reading, Mass. This year I am serving as an elected town meeting member of Reading." . . . **John M. Ting,** Sc.D.'81, has been promoted to associate professor with tenure at the University of Toronto, Department of Civil Engineering. . . . **Jared L. Cohon,** Ph.D.'73, writes, "In July 1986, I assumed the new position of vice-provost for research at Johns Hopkins, Baltimore. I'm responsible for international and multidisciplinary research programs, corporate support of research, technology transfer, and research administrative policy."

Louis H. Roth, Jr., S.M.'47, reports from Denver, Colo., "After 40 years in professional engineering—as an employee, a principal and part-owner of an A/E firm, and an independent consultant—I decided to retire at age 65 in August 1986. I probably would have remained active longer, but my health slowed me down." . . . **Robert J. Etter,** S.M.'65, writes from Sykesville, Md.: "I am now chief engineer of the Large Cavitation Channel (LCC) Project Office at the David Taylor Naval Shipyard. The office is responsible for the design and construction of the world's most advanced variable-pressure recirculating water test facility. It will be operational in 1990 and will circulate water up to 30 knots through a 10' × 10' test section using a 14,000 horsepower motor to drive an 18' diameter axial flow pump. Test section pressure is variable from 1 to 60 psia. The facility will test models of ships and submarines up to 40 feet in length. This test facility will cost between $45 and $65 million." . . . **Kathryn D. Ayan,** S.M.'85, reports, "During the past year I've been working for Geotechnical Engineers, Inc., Winchester, Mass. My current assignment is as field engineer for IBM's new office complex in Southbury, Conn."

Warren B. Powell, Ph.D.'81, has been promoted to the tenured rank of associate professor in the Department of Civil Engineering at Princeton, Powell's alma mater. A 1985 Presidential Young Investigator Award winner, Powell specializes in the development of efficient numerical techniques for solving stochastic systems in transportation. . . . M.I.T. Professors **Robert V. Whitman,** Sc.D.'51, and **M. Nafi Toksoz** were quoted by the Associated Press as a result of their study on seismic risk for the Massachusetts Civil Defense and Office of Emergency Preparedness. They warn New Englanders of possible damaging shocks from an earthquake such as occurred near Cape Ann in 1755. "The study is essentially adopting the attitude that this happened once, and it could certainly happen again. . . . And that's a reasonable basis for planning for emergency response and in terms of losses," they said.

II MECHANICAL ENGINEERING

Assistant Professor **Harry West,** Ph.D'86, of M.I.T. will hold a Mitsui Career Development Professorship for the next two years, using the funding to further develop his work on the design and application of robots for manufacturing tasks.

To **Alexander H. Levis,** Sc.D.'68, senior research scientist at the M.I.T. Laboratory for Information and Decision Systems, the grade of fellow to IEEE to recognize his "applications of system and control theory to complex decision-making processes." . . . To **Ilene J. Busch-Vishniac,** Ph.D.'81, the R. Bruce Lindsay Award of the Acoustical Society of America "for outstanding contributions to developing an improved understanding of the dynamic response of electric transducers and noise propagation in urban environments." Busch-Vishniac is associate professor of mechanical engineering at the University of Texas in Austin, having spent one year following her M.I.T. degree at AT&T Bell Laboratories' Acoustics Research Department. . . . And to Professor **Joseph L. Smith,** Sc.D.'59, of M.I.T., the Edward Longstreth Medal of the Franklin Institute (Philadelphia) "for his work in applying cryogenic techniques to mechanical processes."

Cardiologist **Jeffrey K. Raines,** Ph.D.'72, reports from Coral Gables, Fla., on his latest activities: "director of research and of the Vascular Diagnostic Laboratory, Miami Heart Institute; professor of surgery, University of Miami; and principal investigator, NIH Systolic Hypertension Program." . . . **Serope Kalpakjian,** S.M.'53, professor of mechanical engineering at the Illinois Institute of Technology, Chicago (since 1963), **Nam P. Suh,** who is on leave from M.I.T. to be assistant director for engineering of the National Science Foundation, and **Ernest Rabinowitz,** for 20 years professor of mechanical engineering at M.I.T., have been elected fellows of the American Society of Mechanical Engineers.

Susan Swidler, S.M.'80, reports that she is currently a quality engineer for NYNEX and lives in Stanford, Conn., with her husband and two children. . . . **Jeffrey C. Weil,** Ph.D.'72, reports, "I am a staff scientist with Martin Marietta Laboratories in Baltimore, Md., and am on a one-year leave as a visiting scientist at the National Center for Atmospheric Research in Boulder, Colo. My wife, Sara, and children Katie (age 6), Brandon (age 2), and I are enjoying Boulder and Colorado." . . . **Robert V. Geiger,** S.M.'82, is director of development for Habitat for Humanity, Americus, Ga., an ecumenical Christian housing ministry that works in equal partnership with impoverished people to build homes and rebuild lives and a sense of community. . . . **Michael E. Corbin,** S.M.'72, has been elected vice president/technical director of the Design and Construction Management Division of Roy F. Weston, Inc., West Chester, Penn. Corbin joined Weston in 1976 and has provided the firm with technical leadership in the fields of hazardous and industrial waste management.

Dowell J. Howard, Jr., '49, passed away in Cincinnati, Ohio, in July 1976; no further details are available.



W. R. Prindle

III MATERIALS SCIENCE AND ENGINEERING

A two-year Mitsui Career Development Professorship has been awarded to **Yet-Ming-Chiang,** '80, who holds the Du Pont Assistant Professorship in

A Biologist Honored for Wartime Heroism



The "Woman of Valor" decoration worn by M.I.T. biology professor Annamaria Torriani-Gorini came to her late last spring from the National Conference of Christians and Jews. It honors her for helping more than 800 children of the Holocaust reach Israel through Selvino House in Milan, Italy, between 1945 and 1948.

"Woman of Valor." That heroic designation came to M.I.T. biology professor Annamaria Torriani-Gorini at the Raoul Wallenberg Commemoration held by the Worcester County (Mass.) Chapter of the National Conference of Christians and Jews last spring.

Her award commemorated the time at the end of World War II, when Torriani-Gorini and her late husband, Luigi, sheltered more than 800 Jewish children, many of them orphans and concentration camp survivors.

Torriani-Gorini's service was honored as being in the tradition of Raoul Wallenberg, the Swedish diplomat who rescued thousands of Hungarian Jews from their Nazi persecutors during World War II. He disappeared after being taken into custody by Soviet military police in January 1945.

In fact, Torriani-Gorini and her husband made similar contributions as members of the Resistance in Italy during the war.

This was their story, as told in the program prepared for the ceremony:

"Annamaria Torriani was born in Milan on December 19, 1918. The Torriani family was of Italian nobility since the 12th century. . . . Her mother was 'wildly anti-Fascist.' (Her father, a silk merchant, died in 1928). In 1932, 13-year-old Annamaria was sentenced to 're-education' for anti-Fascist views and activities.

"During the war, Annamaria remained in Milan. Before the fall of Mussolini in September 1943, she was active in the Milan underground, distributing anti-Fascist literature and helping to provide false documents for hunted Jews, political dissidents, and downed Allied airmen. There she met Luigi Gorini of the Socialist resistance, also living on false identification papers and soon to be engaged in conveying arms and ammunition to the Partisans.

"Shortly after the liberation of Milan in April 1944, the Gorinis went to the local Fascist chief (Luigi was carrying a gun although he had never fired one) and announced they were taking a former Fascist youth center, Selvino House, as a refuge for Jewish children from concentration camps.

"Between 1945 and 1948, the Gorinis, with the help of both Jewish Brigade soldiers in the British Army and women from the Jewish settlements of Palestine, sheltered and helped to heal over 800 children who had survived the Holocaust. Aided by sympathetic Italians, the Gorinis helped convey the children on the secret Zionist escape route to Palestine.

"Selvino House was closed after the creation of the State of Israel in 1948. The Gorinis then moved to Paris and in 1956 to the United States. Mrs. Gorini joined the Biology Department at M.I.T. in 1960. She was appointed a full professor of microbiology in 1976, and Luigi, a professor at Harvard Medical School, died in August of that year." □

Ceramics at M.I.T. Chiang has been working in high-technology ceramics since joining the faculty in 1984, the year before he finished his M.I.T. doctorate in the same field.

Thomas W. Eagar, '72, has been promoted to the rank of full professor in the department at M.I.T., and **Carl V. Thompson III,** '76, is now associate professor. Eagar is a specialist in welding who is also interested in materials systems and policy; he's been a member of the faculty since 1976, a year after he received his doctorate from M.I.T. Thompson has specialized in metallic microstructures; he joined the faculty after receiving his Harvard doctorate in 1982.

In-Joo Chin, Ph.D.'83, writes, "I came back home to Korea in August 1986. I am now an assistant professor of polymers in the Department of Polymer Science and Technology at Inha University located in Inchon. . . . From **Melville C. Shine, Jr.,** S.M.'61, of Newton, Mass.: "I have been doing exciting work in the field of fatigue at Digital Equipment Corp." . . . **Eugene J. Michal,** Sc.D.'51, of Golden, Col., informs us that he was elected a distinguished member of the Society of Mining Engineers of AIME in September 1986. . . . **Martin Weinstein,** Sc.D.'61, has been named chairman and chief executive officer of Chromalloy Gas Turbine Corp., New York City, a firm supplying advanced metallurgical services to the gas turbine (jet) engine industry.

William R. Prindle, Sc.D.'55, has been appointed associate director of research, development, and engineering at Corning Glass Works' Sullivan Park Laboratory, Corning, N.Y. Prindle formerly served Corning as director of materials research; he is president of the International Commission on Glass and was 1980-81 president of the American Ceramic Society.

Correction: Neil E. Rogen, S.M.'56, has not resigned from Memory Metals, Inc., Stamford, Conn., as was reported in this space in July (*page MIT 43*). Though he no longer heads the firm that he founded, Rogen continues as a director and member of the executive committee; the *Review*'s statement that he "has resigned from the firm" is incorrect.

Last April, three alumni of the department received an M.I.T. Corporate Leadership Awards to recognize their leadership roles in major business organizations: **Gordon E. Forward,** Sc.D.'66, president and chief executive officer, Chaparral Steel Co.; **William A. Griffith,** '50, chairman, Hecla Mining Co.; and **Roberto Rocca,** '51, president, Organizacion Techint.

Two deaths have been reported to the Alumni Association, with no further details available: **Samuel Valencia,** '49; of Punta Gorda, Fla.; and **Hugo R. Larson,** Sc.D.'51, of Mahwah, N.J.

IV ARCHITECTURE

The memory of **Paul Sun,** M.Arch.'66, was honored early last June at a lecture on "Earth Architecture of China" by Koji Yagi, visiting scholar at M.I.T. from the Tokyo Institute of Technology. Sun, who died on December 8, 1986, was a member of the Boston firm of Shepley, Bulfinch, Richardson and Abbott; he was a founder and board member of the East Asian Architecture and Planning Program at M.I.T.

Two promotions were effective in the department at M.I.T. on July 1: **Stephen A. Benton,** '63, now holds the rank of full professor, and **Ranko**

PHOTO: DONNA COVENEY, M.I.T. NEWS OFFICE

Bon, Ph.D.'75, is associate professor. Benton, who holds advanced degrees from Harvard, has worked extensively in white-light holography and is now active in computational holography, and he is also developing a new undergraduate curriculum in media arts and science. Bon, an architecture graduate of Belgrade University, joined the M.I.T. faculty in building economics in 1983, and he now holds the Macomber Career Development Professorship in Construction Management.

Edith K. E. Ackerman, a psychologist whose specialty is the acquisition of knowledge in children, now holds the Fukutake Career Development Professorship in Research in Education at M.I.T. The new chair is a gift from Fukutake Publishing Co., Ltd., Okayama, Japan, specializing in children's outside-the-classroom learning programs. Assistant professor of media technology, Ackerman holds degrees in experimental, genetic, and clinical psychology from the University of Geneva; she's been associated with Professor **Seymour A. Papert** in learning research since 1985.

Christos Coios, M.Arch.'76, has been named a senior associate of Childs, Bertman, Tseckares, and Casendino, Inc., Boston. Coios has been with the firm since 1982 and has served as guest critic at M.I.T. and the Boston Architectural Center. . . . **Todd L. Siler,** Ph.D.'86, of Cambridge writes, "Completed a two-week U.S.I.S. lecture tour in Pakistan and Israel. I lectured on interaction of the arts with science and technology (and related topics), exploring ideas and images towards an art-science-technology synthesis." . . . **Ernest J. Smith,** M.Arch.'47, reports that he recently retired as founding partner of the Winnipeg, Canada, firm of Smith Carter Partners, architects, engineers, planners, and interior designers. He continues part-time as consultant. The firm has major commercial, educational, medical, and institutional projects across Canada and overseas, wrote Smith. . . . **Mary Murtagh,** M.Arch.'73, is currently executive director of the Ecumenical Association for Housing, an 18-year-old non-profit development corporation in the San Francisco area that builds and manages low- and moderate-income housing. . . . **Barbara D. Putnam,** M.Arch.'77, reports, "My daughter Emma was born June 26, 1984, and I am managing a small house design business of my own, half-time. My work has been published in the local *Litchfield* (Conn.) *Engineer*. . . . **J. Karl Justin,** '48, president and chief executive officer of Justin PC Architects, recently announced that **Jeffrey H. Berman,** '80, has been elected vice-president of the firm. Berman joined Justin in 1980 and served most recently as project manager for the Port Authority of New York and New Jersey, as well as in hospitals and health-related facilities. . . . **George A. Skiadaressis,** M.Arch.'53, writes from Athens, Greece, of his latest activities: professor, Department of Architecture, National Technical University of Athens; president of the Organization for Planning and Environmental Protection of Athens; and president of the National Committee for the European Year of the Environment.

Everett A. Glendening, M.Arch.'54, writes that his firm, E.A. Glendening FAIA/Arch., Cincinnati, "is completing work on a $12 million science research building at the University of Cincinnati. Also, both sons are now architects—one in Minneapolis and the other in New York City. Jim studied with Ralph Rapson, dean at the University of Minnesota and former professor at M.I.T. when I attended, and Tom has a master's degree in architecture from Yale and is at Harvard studying towards his M.B.A." . . . **Roger D. Shepley,** M.Arch.'82, has been named an associate with the Boston architectural firm of Dyer/Brown and Associates, Inc.

V CHEMISTRY

Metal-catalyzed organic reactions will be the subject of research by Professor **K. Barry Sharpless** at M.I.T. under a 1987 Guggenheim Fellowship. His hope is to design new ligands to bind metal atoms in catalyst molecules.

JoAnne Stubbe, professor of biochemistry at the University of Wisconsin, Madison, will join the department at M.I.T. next September 1 as Ellen Swallow Richards Professor. Stubbe won the 1986 Pfizer Award in Enzyme Chemistry from the American Chemical Society, and she'll continue teaching and research at M.I.T. on enzyme chemistry and mechanistic enzymology. Meanwhile, **Sylvia T. Ceyer** and **Keith A. Nelson** were promoted to associate professors in the department, effective July 1. Ceyer, who joined M.I.T. in 1981 two years after finishing her doctorate at the University of California, Berkeley, is a specialist in the physical chemical processes on surfaces; Nelson, who studied at Stanford before arriving at M.I.T. in 1982, is an expert in the analysis of high-speed chemical reactions.

To **John P. Fackler, Jr.,** Ph.D.'60, professor of chemistry and dean of the College of Science at Texas A&M University, the honorary degree of doctor of science at Valparaiso University last May 17. Fackler was honored for his contributions on the chemistry of transition metal compounds and for his services to education in five different universities. . . . A Caltech Distinguished Alumni Award came last spring to **John S. Waugh,** professor of chemistry at M.I.T. His laboratory, said Caltech, has become "one of the leading centers in the world for nuclear magnetic resonance spectroscopy" following Waugh's initial work in development of the process.

To Professor **Mark S. Wrighton,** who became head of the department at M.I.T. on July 1, the 1987 Science Council Prize for excellence in undergraduate teaching. . . . **Joseph B. Mann, Jr.,** Ph.D.'50, retired from Los Alamos National Laboratory in 1986 but continues part-time as laboratory associate. . . . **Mary A. Blanchette,** Ph.D.'86, is currently living in Watertown, Mass., and works for Du Pont in Billerica as a research chemist in the Diagnostic Imaging Division. . . . **Louise H. Foley,** Ph.D.'70, in the Department of Chemistry at the University of New Hampshire, sent the following news item: "On April 3, a number of the former coworkers of Professor **George Buchi,** Camille Dreyfus Professor of Chemistry, gathered at M.I.T. to pay tribute to him with an afternoon symposium and dinner. The symposium speakers were Professors Arigoni and Eschenmoser of the Eidgenossische Technische Hochschule in Zurich and G. Whitesides of Harvard. Fifty-eight former graduate students and post-doctoral fellows of Professor Buchi came from Canada, Germany, Italy, Japan, Switzerland, and the United States to attend both of these events." . . . **William R. Moser,** Ph.D.'64, professor of chemical engineering at Worcester Polytechnic Institute, was recently granted tenure. Moser, a specialist in chemical and metal catalysis, joined WPI in 1981 after 17 years at Exxon and the Badger Co., Inc.



J. Matisoo



W. G. Scott

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Professor **Robert C. Berwick,** Ph.D.'82, of M.I.T. will use his 1987 Guggenheim Fellowship for research on the structure of natural language in the Center for Cognitive Science; he will direct a new project on principle-based parsing, an issue related to man-machine interfacing.

Eight promotions were effective on July 1 in the department at M.I.T.: **Dimitri A. Antoniadis** and **Cardinal Warde** are full professors, and **Rodney A. Brooks, David K. Gifford,** '76, **Shafrira Goldwasser, Bruce R. Musicus,** Ph.D.'82, **Charles G. Sodini,** and **John N. Tsitsiklis,** '80, are associate professors. Antoniadis, trained in Athens and at Stanford, is a specialist in integrated circuit fabrication and is currently director of the M.I.T. Microsystems Technology Laboratories. Warde's field is optical information processing and computation; at M.I.T. since 1974, he is a graduate of Stevens and Yale. Brooks, trained in South Australia and at Stanford, works in artificial intelligence; Gifford is a specialist in computer systems; Goldwasser is a theoretical computer scientist specializing in cryptography following study at Carnegie-Mellon and the University of California, Berkeley; Musicus, at M.I.T. since receiving his doctorate, works in signal processing and VSLI architectures; Sodini, trained in electrical engineering and sociology at Purdue and Berkeley, works in integrated circuit design and fabrication; a theoretician of distributed systems, Tsitsiklis has been a member of the faculty since completing his doctorate.

Professor **Henry I. Smith,** director of the Submicron Structures Laboratory, was elevated to the grade of fellow in IEEE last spring to recognize his contributions to submicron-structures technology. Similar honors came to **Dan E. Dudgeon,** '69, assistant group leader at Lincoln Laboratory, for "contributions to multidimensional digital signal processing," and to **William B. Elmer,** '22, of Andover, Mass., "for development of optical reflector designs for large-scale production and application." . . . A new honor for Professor **Hermann A. Haus** late last spring: membership in the National Academy of Sciences; Haus is Elihu Thomson Professor at M.I.T., an expert in electronic materials and microwave circuits. . . . To Institute Professor Emeritus **Harold E. Edgerton,** '27, the Lifetime Achievement Award of the International Center of Photography for "extending the capabilities of the human eye through high-speed image recording." ". . . a national treasure," said photographer David B. Eisendrath in presenting Edgerton for his award.

Edward Fredkin, formerly director of the Laboratory for Computer Science at M.I.T., made headlines in the Boston press last spring as founder and chairman of the Reliable Water Co., Inc., Boston. A new invention, he told the press, "will allow commercial production of fresh drinking water at about one-third the cost of competing technologies." Three elements of the new machine are credited with its performance: an efficient reverse osmosis unit for actual purification; a patented system that saves energy by transferring pressure from the spent brine to the entering sea water; and a "sophisticated artificial intelligence" system for "total automation."

Plenty of personal experience was represented when **Ronald E. Scott,** Sc.D.'50, spoke to the Boston Section of IEEE last winter on "The Pleasures and Problems of Starting an Engineering School in a Developing Country." Scott's early career—teaching at M.I.T. and then at Northeastern—gave no indication of what was to come. But there was a sudden break in 1967, when Scott left his office as dean of engineering at Northeastern to become founding dean of the University of Petroleum and Minerals in Saudi Arabia. Eleven years later he moved on to Algeria to become for three years head of the National Institute of Electricity and Electronics. With foreign service finally "out of his system," Scott returned to Boston in 1981, first to be dean of engineering at Wentworth Institute and now to be professor of electrical engineering at Northeastern.

M.I.T. President **Paul E. Gray,** '54, was re-elected early this year to a second three-year term on the governing council of the National Academy of Engineering; the Academy's president is **Robert M. White,** Sc.D.'50.

Fred B. Cox, E.E.'59, of Costa Mesa, Calif., reports that he is chairman, chief executive officer, and founder of Emuler Corp. The firm specializes in data storage and data communications products for computer application/enhancement and has recently reported annual revenues of $105 million and a staff of more than 850. . . . **Paris C. Kanellakis,** Ph.D.'82, associate professor at Brown University was among 90 young scientists to receive a Sloan Research Fellowship of $25,000. Kanellakis will use his grant to further research on the theory of databases, parallel computations, and logic. . . . **Wilbur L. Pritchard,** E.E.'52, is president of Satellite Systems Engineering, Inc., Bethesda, Md., a 30-person consulting engineering firm in satellite communications. . . . **Kenneth Van Bree,** E.E.'71, on the staff of the Hewlett Packard Co., Palo Alto, Calif., reports that on May 2 he married Gloria Griffin in a garden ceremony in Saratoga, Calif. . . . **Joseph Humel,** S.M.'86, is presently employed at Denning Mobile Robotics, Inc., Woburn, Mass.

IBM has named **Juri Matisoo,** S.M.'60, research division vice-president, storage, and director of the Almaden Research Center, San Jose, Calif. Formerly, Matisoo served as director of silicon technology at IBM's Thomas J. Watson Research Center, Yorktown Heights, N.Y. . . . **Charles B. Sharpe,** S.M.'49, reports from Ann Arbor, Mich., that he retired after 32 years of teaching in the Department of Electrical Engineering and Computer Science at the University of Michigan.

Nelson E. Bolen, E.E.'62, recently changed jobs at the Mitre Corp., Bedford, Mass.: from associate technical director in Division D-40, Strategic Command and Control, to Division D-50, Tactical Communications. From Mitre's McClean, Va., operation comes news that **James H. Babcock,** S.M.'62, joined the firm as chief engineer of the Washington C^3I Division. Previously, Babcock served as vice-president of the IRT Corp. and president of its National Security Systems Division. . . . **William G. Scott,** S.M.'81, has been named vice-president, engineering, of the Information Networks Division at Contel ASC (formerly American Satellite Co.), Rockville, Md.; previously he served as Contel ASC's director of Systems Development Engineering.

Five alumni of the department received M.I.T. Corporate Leadership Awards last April, recognizing them as "exceptional contributors to the continued strength and well-being of the American economic system": **Fred B. Cox,** E.E.'59, chairman and chief executive officer, Emulex Corp.; **Einar Greve,** S.M.'53, president and chief executive officer, Tucson Electric Power Co.; **David B. Leeson,** S.M.'59, chairman, California Microwave, Inc.; **R. Gene Shelley,** '49, president, Raytheon Co.; and **Charles A. Zraket,** S.M.'53, president and chief executive officer, The Mitre Corp.

Three deaths have been reported to the Alumni Association, with no further details available: **Warren K. Muldrow,** '87, a student in the Health Policy and Management Program at M.I.T., on April 10, 1987; **Walter B. Renhult, Jr.,** '49, of Concord, Mass., on August 21, 1985; and **Kenneth A. Young,** S.M.'49, of Groton, Mass., in November 1986.

VI-A Internship Program

June is the month of graduations and other honors and awards. Traditionally, many VI-A'rs are recipients of these accolades, and this year is no exception. The parade began at the Institute's Awards Convocation on May 6, when the head of this Department's Graduate Office and past Chairman of the Faculty Professor **Arthur C. Smith** was one of the recipients of this year's Gordon Y Billard Awards. The Billard Award is given for special service of outstanding merit performed for the Institute; it was funded by the late Mr. **Billard,** '24. Since its establishment in 1963, three other department members have received this prestigious award: Institute Professor (Emeritus) **Harold E. Edgerton,** Sc.D.'31, Professor



Model Cheryl Tiegs presents Professor Emeritus Harold ("Doc") E. Edgerton, '27, with the Lifetime Achievement Award of the International Center of Photography. Introducing Tiegs to "Doc" and Mrs. Edgerton is Cornell Capa (center), director of the center, who cited Edgerton for "laying the foundation for the modern electronic flash."

James D. Bruce, Sc.D.'64, and your correspondent. It was my pleasure to welcome Professor Smith to this group following the ceremony!

Receiving one of the awards for excellence in teaching from the Graduate Student Council was Professor **Jeffrey H. Lang,** Ph.D.'80, who currently serves as our VI-A Faculty Advisor to the Draper Laboratory. . . . One of two Laya and Jerome B. Wiesner Awards for achievement in the creative and performing arts was given to **Patricia A. Zeitler,** '88. . . . **Janet L. Pan,** '87, received one of the two Association of M.I.T. Alumnae Awards for outstanding senior women demonstrating the highest level of academic excellence through course work and professional activities. . . . And **Joseph E. Bondaryk,** '87, received honorable mention for the Frederick G. Fassett, Jr., Award for a member of the Interfraternity Conference who has unselfishly demonstrated qualities of spirit, dedication, and service in furthering the ideals of the M.I.T. fraternity brotherhood.

The next award occasion was that of the EECS Department's annual Spring Party on May 17, held for the second consecutive year in the new West Wing of Boston's Museum of Fine Arts. The award for the outstanding undergraduate thesis in electrical engineering, given in memory of Professor **Ernst A. Guillemin,** '24, was won by **Robert G. Atkins,** '87.

Two VI-A'rs won the Department's Undergraduate Laboratory Prize, given in memory of Professor **George C. Newton, Jr.,** Sc.D.'50, former executive officer of the Department: **Lawrence M. Candell,** '88, and **Adam L. Schwartz,** '88.

A few outstanding engineering students are elected by M.I.T.'s Phi Beta Kappa Chapter each year to recognize their outstanding attainments in the humanities as well as in their major fields. One of those this year was VI-A'r **Wilson C. Hsieh,** '87, who has worked at IBM in Kingston, N.Y., and at the Watson Laboratory in Yorktown Heights, N.Y.

And lastly, for outstanding teaching, **Katherine A. Yelick,** '85, was promoted to Instructor-G in the department, where she will continue graduate study. All told, wonderful achievements by participants in the VI-A Program, of which we can all continue to be proud!

Looking forward to an interesting trip to mainland China this summer is Adjunct Professor **Robert H. Kingston,** Ph.D.'51. Bob, who visits me quite regularly from his office across the corridor, is associate group leader at M.I.T.'s Lincoln Laboratory and has been teaching in the department for the past several years. He has been invited to lecture at Tsinghua University in Beijing. Bob will be following in the footsteps of the late Professor (Emeritus) **Karl L. Wildes,** '22, who taught at this same university just prior to the start of World War II. It was there that Professor Wildes became acquainted with Professor (Emeritus) **Y. W. Lee,** Sc.D.'30, who, after the war, emigrated to M.I.T. and worked in the Electrical Engineering Department and with Professor Norbert Wiener in the Research Laboratory of Electronics—and also with Professor **Amar Bose,** Sc.D.'56, founder of the Bose Corp.

Michael A. Isnardi, Ph.D.'86, member of the Technical Staff of the David Sarnoff Laboratory, Division of SRI, is the recipient of the 1987 Marconi Young Scientist Award for his "novel, compatible method of increasing the information transmitted within a television channel." This award is given to a promising scientist no older than 27, Marconi's age at the time of his first trans-Atlantic radio transmission. The presentation was made at the Smithsonian Institution in Washington, April 8.

The following VI-A'rs attended the Semi-Annual VLSI Review on May 18: **A. George Foyt,** Sc.D.'65, of United Technologies Research Center; **Philip B. Giangarra,** S.M.'78, of Motorola's Codex Corp.; **Wai L. Lee,** S.M.'87, just completing his Master's work, who presented his thesis as one of the papers; and **Mark W. Reichelt,** still on his graduate program at M.I.T. Chairman of the Review was Professor **Paul L. Penfield, Jr.,** Sc.D.'60, director of M.I.T.'s Microsystems Research Center. Paul serves as VI-A Advisor to the Raytheon Co.

Our condolences to **Chester M. Day, Jr.,** S.M.'58, on the recent death of his father, also a VI-A'r, class of '28. It is interesting to note that when I was affiliated with the Bell System (1950-56) I became acquainted with **Chester M. Day, Sr.** Later, when I came to M.I.T. (February 1956), I met Chester Jr., who participated in VI-A. His son, Stephen, graduated from Course VI last month. Chet Jr. is currently one of our VI-A coordinators at Bellcore in Holmdel, N.J.

PHOTO: CHESTER HIGGINS, JR.

Members of M.I.T.'s Tau Beta Pi Chapter elected the following VI-A's to serve as officers for the coming academic year: **Richard D. Wesel,** '88 (President); **Thomas W. Humphrey,** '88 (Cataloguer); and **Lucene L. Tong,** '88 (Treasurer).

On May 20 we had a surprise visit from **Geoffrey J. Bunza,** Ph.D.'81, who was east seeking several new managers for Mentor Graphics, Beaverton, Ore., where he is now director of engineering in the company whose co-founder was **Stephen Swerling,** '63. Steve served as the first VI-A technical co-ordinator at Tektronix when the company was added to the VI-A Program in 1981.

We learned, recently, that **David A. Krall,** S.M.'83, has been accepted at Harvard Business School starting this fall.

We also had a visit one afternoon from **H. DuBose Montgomery,** S.M.'72, of Menlo Park, Calif., who was at M.I.T. on alumni business. DuBose is a partner in Menlo Ventures, Inc. Another member of that firm is **John W. Jarve, Jr.,** S.M.'79, who has helped run our annual West Coast VI-A Picnic for the past several years.

Coming by for a visit, but unfortunately when I was out, was **J. William Poduska,** Sc.D.'62, founder of Prime, Apollo and Stellar Computers, Inc. Bill was an assistant professor in this department when I first came to M.I.T. (1956) and was a sometime squash partner of mine.

As this is written we look forward to graduation on June 1, and Technology (Alumni) Day on June 5, when we'll predictably meet many alumni on whom we'll report in the next issue. Please write if you have interesting VI-A news to report.—John A. Tucker, Director, VI-A Internship Program, M.I.T., Room 38-473, Cambridge, MA 02139

VII BIOLOGY

Two promotions in the department at M.I.T., effective July 1: **Robert T. Sauer** is now full professor, and **David H. Raulet,** Ph.D.'81, is associate professor. Raulet's research is in cellular immunology, while Sauer is recognized as a "world leader in one of the most important and fundamental areas of modern biology—the chemistry of the interactions of proteins and nucleic acids involved in the regulation of gene expression."

Professor **Harvey F. Lodish** of M.I.T. was honored by election to the National Academy of Sciences late last spring; his work is in the field of genetics and molecular biology.

Steven E. Lohrenz, Ph.D.'85, writes that last September he was married to Maura Connor; he is currently a post-doctoral fellow (National Research Council) with the Naval Ocean Research and Development Activity, Bay St. Louis, Miss. . . . **Ward J. Haas,** Ph.D.'49, has joined the Manhattan Consulting Group, New York City, as a principal to lead the firm's activities in research and development effectiveness. Haas has spent more than 20 years in senior management of research and development in industry and universities, most recently as vice-president of Chesebrough-Ponds, Inc.

VIII PHYSICS

To Institute Professor Emeritus **Philip Morrison,** the first Andrew Gemant Award of the American Institute of Physics for "deep and broad contributions to the understanding of the aesthetic dimension of physics. In our day of specialists, he is the ultimate generalist, celebrating the joy of unbridled intellectual curiosity," said AIP's citation. . . . Meanwhile, Polaroid announced that Morrison's contributions to popular understanding of science are by no means a thing of the past: he will host a new Polaroid-financed series, "The Ring of Truth," on public television next fall. The series will be devoted to the nature of scientific discovery, a celebration of Polaroid's 50th anniversary.

Professor **Cyril M. Harris,** Ph.D.'45, of Columbia University was honored last spring with the Gold Medal of the Acoustical Society of America "for service to the society, for improved understanding of the absorption of sound in gases, and for contributions to the science and practice of architectural acoustics." Before his recent retirement, Harris held faculty appointments in both electrical engineering and architecture and was chairman of the Division of Architectural Technology at Columbia. At the same meeting, ASA gave its Biennial Award, newly named in honor of **R. Bruce Lindsay,** Ph.D.'24, to **Ilene J. Busch-Vishniac,** Ph.D.'81, associate professor of mechanical engineering at the University of Texas at Austin.

Albert Wheelon, Ph.D.'52, chairman of the board and chief executive officer of the Hughes Aircraft Co., has been named to the Board of Trustees of the California Institute of Technology. . . . Professor **Janet B. Guernsey,** Ph.D.'55, of the Physics Department at Wellesley is chairman of the Building Fund Committee for the American Association of Physics Teachers. . . . **Merrill L. Andrews,** Ph.D.'68, is chairman of the Physics Department at Wright State University, Dayton, Ohio.

Lynn R. Cominsky, Ph.D.'81, of El Cerrito, Calif., writes "Associate professor in the Physics and Astronomy Department at Sonamoa State University. Have recently received AAS small research grant and NASA Space Astrophysics Data Analysis grant to continue x-ray astronomy research on compact x-ray binaries." . . . **Robert N. Noyce,** Ph.D.'53, vice-chairman of the Board of Directors of Intel Corp., Santa Clara, Calif., was given the American Association of Engineering Societies' highest honor—The National Engineering Award—last April "for outstanding contributions to the benefit of mankind."

John A. Hornbeck, Ph.D.'46, of St. Simons Island, Ga., passed away on January 30, 1987; no further details are available.

IX BRAIN AND COGNITIVE SCIENCES

Three promotions effective July 1: **Suzanne Corkin** and **Shimon Ullman,** Ph.D.'77, are now full professors in the department at M.I.T., and **Jeremy M. Wolfe,** Ph.D.'81, is associate professor. Corkin came to M.I.T. in 1964 as a research associate working on memory dysfunction, long-term effects of head injury, and Alzheimer's disease. She joined the faculty as associate professor in 1981 and since 1986 has been associate director of the Clinical Research Center. Ullman began his career at M.I.T. in the Department of Electrical Engineering and Computer Science, where he was research associate following his doctorate. In 1980 he moved to the Artificial Intelligence Laboratory and a year later to the Department of Psychology, where he became associate professor. Wolfe is widely known at M.I.T. for his teaching of the undergraduate introduction to psychology; his research interests are in the area of vision with a psychophysical approach.

A five-member interdepartmental steering committee headed by Professor Wolfe is now in charge of an interdisciplinary teaching program in psychology at M.I.T. The idea is to provide "an umbrella for teaching and intellectual interaction" among the psychologists in many Institute departments. There will be courses for undergraduate and graduate students and a series of colloquia.

X CHEMICAL ENGINEERING

Ulrich W. Suter has been promoted to the rank of full professor in the department at M.I.T. He's a specialist in polymer structures and properties and a major contributor to the departments' curriculum in this field. A graduate of Eidgenossische Technische Hochschule, Zurich, Suter has been a part-time visiting professor there and at M.I.T. since completing his doctorate in 1980.

Arthur R. Winters, Jr., S.M.'52, writes, "Upon my retirement from Air Products in December 1986, I joined Cryogenic Consultants, Inc., Allentown, Penn." . . . **W. Henry Tucker,** Sc.D.'47, writes from Riverside, Calif., that he is retired but remains active as president of a new organization, Southern California Friends of World Neighbors and as the author of a new appropriate technology directory, *Alternative Energy Today,* for Tranet, Rangeley, Me. . . . **Salim M. Edde,** S.M.'81, writes, "I have started a software development company in Paris, specializing in decision support systems for the hydrocarbon processing (process simulation) and the banking industries (portfolio simulation)."

Harris J. Bixler, Sc.D.'60, has been elected chairman of the Board of Governors of Bigelow Laboratory for Ocean Studies. Bixler is owner of the business development firm of Brown's Head Ventures, Belfast, Me.

In recognition of their leadership roles, **Robert J. Richardson,** Sc.D.'54, president, Bell Canada Enterprises, Inc., and **Arch C. Scurlock,** Ph.D.'48, president, Research Industries, Inc., were presented M.I.T. Corporate Leadership Awards last April 24.

Richard A. Novak, S.M.'80, writes, "I am currently a senior development engineer at Air Products and Chemicals, Allentown, Penn. I work in corporate research and development on technology evaluation and new business development." . . . **Christiaan P. Lebeer,** S.M.'81, writes from Brussels that he is an engagement manager in McKinsey & Co.'s Benelux office, involved in strategy, organization, and operations effectiveness work in the process industry. His assignment involves extensive travel through Europe.

Three deaths have been reported to the Alumni Association with no further details available: **William M. Creasy,** S.M.'36, retired major general who rose to be Commander of the Army Chemical Corps, in Palm Desert, Calif., in March 1987; **John R.B. Ellis,** S.M.'40, of Kentfield, Calif., in November 1985; and **Edward J. Schmidt,** S.M.'47, of New York City, in 1987.

XI URBAN STUDIES AND PLANNING

Lynne B. Sagalyn, Ph.D.'80, was promoted to the rank of associate professor in the department at M.I.T. effective July 1. She's a specialist in real estate finance and financial decisions, and she and Professor **Bernard J. Frieden,** Ph.D.'62, are co-authors of a new book on downtown development.

Alan Wofsy, M.C.P.'67, recently became publisher of the *San Francisco Review of Books.* Wofsy writes, "Unsolicited reviews and essays are welcome. M.I.T. graduates might wish to contribute to the 'State of the Art' column. Write editor at: 1117 Geary St., San Francisco, Calif. 94109." . . . **Philip Shapira,** M.C.P.'79, reports from Washington, D.C., "Completed doctoral degree (Ph.D.) in city and regional planning at the University of California, Berkeley, in November 1986. Currently, Congressional Fellow with the Office of Technology Assessment, U.S. Congress, Washington, working on an assessment of technology, innovation, and U.S. trade." . . . **Richard A. Conway,** a corporate fellow at Union Carbide's Technical Center, South Charleston, W.Va., is a recipient of *Chemical Engineering* magazine's Award for Personal Achievement in Chemical Engineering.

XII EARTH, ATMOSPHERIC AND PLANETARY SCIENCES

Kip V. Hodges, Ph.D.'82, was promoted to associate professor in the department at M.I.T., effective July 1. His research and teaching are in structural geology, and he's made a specialty of innovative methods for determining the conditions of temperature and pressure to which rocks have been subjected during formation.

Robert M. White, Sc.D.'50, began his second four-year term as president of the National Academy of Engineering on July 1. Before moving to Washington in 1982, White was president of the University Corporation for Atmospheric Research, a 50-university consortium with research programs in atmospheric sciences and technology.

Louis Berger, S.M.'40, chairman of Louis Berger International, Inc., was honored with an M.I.T. Corporate Leadership Award last April.

XIII OCEAN ENGINEERING

Two promotions to the rank of associate professor were effective at M.I.T. on July 1: **Dale G. Karr,** a specialist in Arctic engineering, and **Dick Y. Yue,** '74, whose field is analytical and computational fluid dynamics. Karr studied at Michigan State, Tennessee, and Tulane; at M.I.T. since 1983, her research and teaching have been on ice/structure interactions. Yue had a postdoctoral year at M.I.T. after receiving his Sc.D. in 1980, and he's been a member of the faculty since 1983.

Lawrence K. Donovan, S.M.'71, writes, "Retired from the Navy (as captain) in October 1985, and am now working as an engineering manager for Bechtel National, Inc., San Francisco. My family and I are living in Walnut Creek, Calif." . . . **Nguyen T. Hull,** S.M.'61, reports that he is a naval architect living in Oran, Algeria. . . . **Owen H. Oakley, Jr.,** Ph.D.'72, is working in Indonesia constructing an oil rig for Chevron. Oakley reports that he has been there for one year with plans to remain for the next several. . . . **Robert P. Dickenson,** S.M.'69, writes, "Retired from the United States Coast Guard in 1984 and now offering consulting services in the areas of marine design, project planning, management, engineering, and maintenance." He, Mary Irene, and their four children are living in Nahant, Mass. . . . **John J. McMullen,** S.M.'45, chairman of the board of John J. McMullen Associates, Inc., was one of 64 alumni presented with an M.I.T. Corporate Leadership Award last April 24.

Frederic H.E. Vose, N.E.'53, a retired commander (since 1967) in the U.S. Navy, passed away in Newport News, Va., on August 28, 1986. Vose retired from Newport News Shipbuilding in 1984, after 17 years as a quality assurance engineer. Involved in active naval duty from 1956 to 1967, Vose was associated with the nuclear propulsion program under Admiral Hyman J. Rickover. He also served as chief engineer for the *USS Boxer* and at the Naval Ship Systems Command in Washington, D.C. Among his professional affiliations, Vose was a member of Sigma Xi, the Society of Naval Architects and Machine Engineers, and the American Society of Mechanical Engineers.

XIV ECONOMICS

Two promotions in the department at M.I.T. were effective July 1: **Jean M. Tirole,** Ph.D.'81, is now full professor, and **Garth Saloner** has the rank of associate professor. Tirole is described as "a theorist of great power, insight, and versatility" whose major work has been applying incentives and game theory to problems in industrial organization; Saloner, whose Ph.D. (1982) is from Stanford, is a specialist in industrial competition, price wars, and the business cycle.

The determinants of corporate financial structure will be the subject of research by Professor **Oliver D. Hart** of M.I.T. under a 1987 Guggenheim Fellowship. Specifically, he says, he wants to analyze how financial structure relates to takeover potential.

Energy, Markets, and Regulation is the title of a collection of essays published last spring by the M.I.T. Press in honor of Professor **Morris A. Adelman** of M.I.T. The editors: **Richard L. Gordon,** Ph.D.'60, professor of mineral economics, Penn State; **Henry D. Jacoby,** professor of management, M.I.T.; and **Martha B. Zimmerman,** Ph.D.'75, associate professor of economics, University of Michigan. Adeleman is described as "the dean of academic economists concerned with energy markets and the effects of government regulation." Among the contributors, in addition to the editors: **Ernst R. Berndt,** professor of applied economics, M.I.T.; **Paul G. Bradley,** Ph.D.'66, professor of economics, University of British Columbia; **Paul R. Carpenter,** S.M.'78, vice-president of Incentives Research, Inc., Boston; **Paul L. Eckbo,** Ph.D.'76, chief executive officer of Marsoft, Inc.; **Theodore E. Keeler,** Ph.D.'71, professor of economics, University of California, Berkeley; **Charles P. Kindleberger,** professor emeritus of economics, M.I.T.; **Paul W. MacAvoy,** professor of management, University of Rochester; **Jeffrey K. MacKie-Mason,** Ph.D.'86, assistant professor of economics, University of Michigan; **Robert S. Pindyck,** Ph.D.'71, professor of applied economics, Sloan School; **Philip K. Verleger, Jr.,** Ph.D.'71, Institute for International Economics, Washington, D.C.; **David O. Wood,** associate director of the M.I.T. Energy Laboratory; **Arthur W. Wright,** Ph.D.'69, professor of economics, University of Connecticut; and the late **Zenon S. Zannetos,** Ph.D.'59, formerly professor of management, M.I.T.

To Institute Professor Emeritus **Paul A. Samuelson,** an honorary doctorate from Valparaiso University, Indiana, at Commencement Exercises last May 14. It was by Valparaiso's count his 27th honorary degree. . . . To **George P. Shultz,** Ph.D.'49, secretary of state, the Ernest C. Arbuckle Award of the Stanford Business School Alumni Association. The award recognizes excellence in management leadership; Shultz is on leave from his post as Stanford's Jack Steele Parker Professor of International Economics.

Carl Shapiro, Ph.D.'81, who has taught economics and public affairs since 1980 at Princeton, has been promoted to associate professor. Shapiro teaches undergraduate and graduate industrial organization and applied microeconomics, holds a 1985 Alfred P. Sloan Foundation research fellowship, and is co-editor of *The Journal of Economic Perspectives* and associate editor of the *Quarterly Journal of Economics*. . . . **Lawrence H. Summers,** '75, professor of economics at Harvard, has been selected from 110 nominees to receive the National Science Foundation's Alan T. Waterman Award. Summers, the first economist to win the award since its inception, has focused his research interests on the economic analysis of capital and labor markets.

Michael P. Mazur, Ph.D.'72, an economist with the Division of Regulatory Affairs at the Office of Management and Budget for the past six years, passed away on January 22, 1987 in Alexandria, Va. Before joining OBM in 1980, Mazur taught at Yale University and Dartmouth College.

XV MANAGEMENT

Seven members of the Sloan School faculty have been promoted, effective July 1:

☐ **Arnold I. Barnett,** Ph.D.'73, is now a full professor, specializing in operations research and other applications of mathematics in business analyses; he joined the Sloan School in 1975, having previously served as instructor in mathematics—the area in which he took his doctorate.

☐ **Robert M. Freund,** who came to M.I.T. as assistant professor of management science in 1983, is now associate professor; his special interest is mathematical programming.

☐ **Stephen C. Graves,** a specialist in operations management and applied operations research, is now full professor. His publications, including his University of Rochester thesis (Ph.D. 1977), are in industry management and the control and design of production systems.

☐ **Chi-fu Huang** is now associate professor; he came to the Sloan School from Stanford in 1983 to work in financial economics and economic theory.

☐ **Judith A. Lachan,** now associate professor of

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management, is a specialist in such legal issues as labor relations, negotiation, torts, and taxation. She has a law degree from Yale in addition to degrees in management from Michigan State.

□ **James B. Orlin,** at M.I.T. since 1979, is now full professor in the field of mathematical programming and industrial logistics. His degrees are from Pennsylvania, Caltech, and Stanford.

□ **Robert J. Thomas,** formerly at Boston College, is now associate professor of organizational studies at the Sloan School. Thomas taught for four years at the University of Michigan following his doctorate from Northwestern (Ph.D. 1918).

Richard A. Levine, S.M.'63, senior vice-president of Lester B. Knight and Associates, Inc., Chicago, is president-elect of the Institute of Management Consultants, Inc.; he'll take office in April 1988, when **Carl H. Poedtke, Jr.,** '59, a partner of Price Waterhouse, will be completing his first term as a director of IMC. Poedtke is based in Chicago and resides in Lake Forest, Ill.; Levine lives in Larchmont, N.Y.

Joseph C. Profita, S.M.'47, is a management consultant specializing in strategic planning and project implementation. He and his wife, Peg, live on their producing lemon and avocado orchard in Vista, Calif. . . . **Charles N. Smart,** S.M.'79, reports that on May 24, 1986, he married Ann M. Levis (Manhattanville '70; M.Ed., Boston University '71) and on March 12, 1987, their daughter Caroline Amelia was born. "Mother, father, and daughter are all doing fine!" wrote Smart.

Maria-Olivia Gonzales, S.M.'79, reports, "I started a business over a year ago, designing textile-based toys under the trademark of Sofstix Playmat. The toys were featured under "Best Bets" in *New York Magazine*'s November 18, 1986, issue. The boutiques carrying the Playmats are doing very well. I have two children, Ziggie (age 3) and Kayelle (21 months)." . . . **Geoffrey S. Stiff,** S.M.'80, is currently manager of financial analysis and planning for General Electric, Fairfield, Conn.

Aristea Xafa, S.M.'75, financial consultant with Quantum Corp., Boston, has been listed in the 25th edition of *Who's Who in Finance and Industry*. Some of his former posts listed: assistant financial manager for Omran Techlar, Tehran, 1975-78; advisor to the president of the Onassis Group, 1981; financial vice-president of Global Investments, Boston, 1981-84; and consultant to the Global Monetary Project, 1983—. . . . **John M. Hennessy,** '70, chairman and chief executive officer, Credit Suisse First Boston, Inc.; **Mitchell L. Kapor,** '81, chairman, Lotus Development Corp.; the late **Thomas E. Reilly, Sr.,** '37, chairman emeritus, Reilly Tar & Chemical Corp.; and **Gosta A. Virding,** '39, president, Pharmacia AB, received M.I.T. Corporate Leadership Awards in ceremonies at the Institute last April 24. Reilly's award was posthumous; he passed away on March 2 in Indianapolis. . . **John Roach,** '65, has joined the staff of the Manville Corp., Denver, Col., as chief financial officer and senior vice-president. Roach was formerly a partner of Braxton Associates.

Sloan Fellows

The following alumni received M.I.T. Corporate Leadership Awards last April 24: **David L. Chapman,** S.M.'70, vice-chairman and chief executive officer, Cullinet Software, Inc.; **Robert B. Horton,** S.M.'71, chairman and chief executive officer, The Standard Oil Co.; **William O. McCoy,** S.M.'68, vice-chairman, Bellsouth Corp.; **Vinod K. Sood,** S.M.'64, chairman and chief executive officer, and **E. Maurice Young,** S.M.'61, chairman of the board, Finning Tractor & Equipment Co., Ltd.; and **E. Joseph Zemke,** S.M.'77, chief operating officer, Amdahl Corp.

Barbara Bennett Perry, S.M.'81, has been advanced from chief operating officer to president of Bennett Box & Pallet Co., Inc., Asoskie, N.C. Perry, granddaughter of the firm's founder, joined the firm in January 1980 as assistant to the chairman; previously she had been director of research and planning for the Bank Marketing Association, Chicago. . . . **Philip B. Fletcher,** S.M.'70, has been named president and chief operating officer of ConAgra Prepared Food Companies, Omaha, Neb. Fletcher joined ConAgra in 1984 after assignments at Campbell Soup Co., H.J. Heinz, and Heublein Co., and in his new post will continue as a member of the Office of the President. '. . . **Robert L. Swann,** S.M.'85, has been named manager of systems and engineering, Communications Products Division, at International Business Machine Corp., Boca Raton, Fla. Formerly, he was large systems project office manager in IBM's Data Systems Division, Poughkeepsie, N.Y.

Ira Dorsey, S.M.'84, a lieutenant colonel in the United States Army, passed away in Springfield, Va., on March 30, 1987.



Carroll L. Wilson ('32) Awards were given late last spring by Constantine B. Simonides, '57, vice-president of M.I.T., to (left to right) Ikem S. Okoye, Mutsumi R. Mizuno, '88, and Stephen R. Rintoul. Okoye, a graduate student in architecture, will use his $5,000 award to study alternative building technologies for West Africa; political science major Mizuno, plans a comparative study of U.S. and Japanese patent law; and Rintoul, a graduate student in earth sciences, will study deforestation in India. The awards, established by a group of his former students, honor the late Professor Wilson for his leadership in studying world-scale environmental problems.

Senior Executives

Joseph A. Baute, '64, chairman and chief executive officer, Markem Corp.; and **James D. Harty,** '76, president and chief operating officer, Raymond Corp., were honored with M.I.T. Corporate Leadership Awards last April 24.

Management of Technology Program

Enrico Poggio, S.M.'85, visited the Program Office in early May and met with the new program director, Mario Gnecco. Enrico, who is with Nichols Research Corp., was here at M.I.T. on business.—Jacalyn Walker-Sharp, Program Coordinator, M.I.T., Room E52-125, Cambridge, MA 02139.

PHOTO: DONNA COVENEY, M.I.T. NEWS OFFICE

XVI AERONAUTICS AND ASTRONAUTICS

R. John Hansman, Jr., Ph.D.'82, now holds the rank of associate professor at M.I.T. Hansman is a specialist in instrumentation and has concentrated on measuring factors critical to performance and safety; he's also made important contributions to the department's undergraduate projects laboratory and has established a graduate subject in instrumentation.

Gautham Ramohalli, S.M.'81, on the staff of Honeywell Systems and Research Center, Minneapolis, received the firm's Technical Achievement Award "for contributions in developing an integrated digital flight control/navigation system that reduces pilot workload for the Army's Lightweight Helicopter (LHX) Program." The award was presented last February 26 on Engineers' Day 1987. . . . Commander **William H. Cullin,** S.M.'47, retired from the faculty of the Naval Postgraduate School, Monterey, Calif. and is living in Carmel, Calif. . . . **J. Edward Anderson,** Ph.D.'62, of Revere, Mass., writes that he is president and chairman of Taxi 2000 Corp. He has invented, developed, and now is involved in commercializing a new form of public transportation using small, automatically controlled vehicles, traveling non-stop between stations in a network of guideways.

Two deaths have been reported to the Alumni Association, with no further details available: Captain **Jess W. Barnes,** S.M.'49, of Pensacola, Fla., on February 16, 1987; and Captain **George F. Kosco,** S.M.'40, of Harrisburg, Penn., on June 11, 1986.

XVII POLITICAL SCIENCE

On the eve of his departure from M.I.T., Associate Professor **Brian H. Smith,** was honored with the 1987 Everett Moore Award for Excellence in Undergraduate Teaching by the undergraduate Baker Foundation. "Working with students is what I most enjoy," Smith told *The Tech* after receiving the prize. "I feel wonderful about the award—very satisfied."

Christine F. Ridout, Ph.D.'85, has been appointed assistant professor in the Political Science Department at the University of Lowell, Lowell, Mass. Ridout was formerly on the staff of Framingham State University.

XVIII MATHEMATICS

Lloyd N. Trefethen, who joined the M.I.T. faculty in 1984 after studies at Harvard and Stanford, is now associate professor in the department. Trefethen's research and teaching are in numerical analysis, the field in which he won the first Fox Prize in 1985. . . . Professor **Alan Toomre** of the department was honored with the 1987 M.I.T. Science Council Prize for excellence in undergraduate teaching.

XX APPLIED BIOLOGICAL SCIENCES

Alexander M. Klibanov has been promoted to the rank of full professor at M.I.T., and **Marsha Rich Rosner,** Ph.D.'78, to the rank of associate professor. Klibanov, trained at Moscow University, is a leader in applied enzymology and enzyme stabilization; Rosner's work has been in growth factor regulation in cellular membranes.

Ara Nahapetian, Sc.D.'71, is in research and development in the field of cell biology at E.I. du Pont Nemours & Co.'s Medical Products Department, Wilmington, Del. . . . **Daniel F. Farkas,** Ph.D.'60, has been named vice-president of process research and development at the Campbell Institute for Research and Technology, Camden, N.J. He was previously chairman of the Department of Food Science, University of Delware. . . . **Maria Amanda Galvez,** S.M.'83, writes from Mexico, "I am presently working on the design and development of dietotherapies for hospitalized and for phenylketonuria (PKU) patients, as well as on dextranases production (the latter for my Ph.D. thesis).

XXI HUMANITIES

Theoharis C. Theoharis, assistant professor of literature, was honored with the Everett M. Baker Award for Excellence in Undergraduate Teaching at the close of the 1986-87 academic year; the award is managed by undergraduates, the selection process "based completely on teaching ability," according to the student chairman of the foundation, Alan M. Davidson, '89.

TECHNOLOGY AND POLICY PROGRAM

Deborah Estrin, S.M.'83, is now an assistant professor of computer science at the University of Southern California.—Richard de Neufville, Chairman, M.I.T., Room 1-138, Cambridge, MA.

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Zenon S. Zannetos, 1928-1987: Teacher/Practitioner of Management

An outstanding career in management education was cut short on May 2 with the death of Professor Zenon S. Zannetos, Ph.D.'59, senior associate dean for development at the Sloan School of Management; he was 59.

Zannetos entered the M.I.T. Graduate School in 1953, and he remained at the Institute thereafter except for brief absences. He received his master's degree in management in 1955 and joined the Sloan School faculty in 1961 after receiving his doctorate in economics and taking a year of postdoctoral studies in mathematical statistics at Stanford.

Zannetos' research and teaching interests spanned a wide range—managerial planning and control systems, accounting, the design of organizational structures, productivity and innovation, petroleum economics, and the impact of technology on education. Abraham J. Siegel, dean of the Sloan School at the time of Zannetos' death, described his as "an important contributor to the Sloan School for more than 30 years . . . in the classroom, in his research, and in the important administrative help he provided." Zannetos' publications included two books and more than 70 major professional papers.

Zannetos was visiting professor in economics at Harvard in 1962-64, and he was the first Forrestal Professor of Management at the Naval War College, Newport, R.I., in 1967-68. For a decade thereafter, Zannetos served as part-time academic director for the Senior Officers Management Course at the War College.

He also applied his management skills as founder and chief executive officer of Pericomp Corp., Natick, Mass., as a founder of Palladian Software, Inc., Cambridge, as a consultant to several firms for which he served as director.

Born in Famagusta, Cyprus, Zannetos came to the U.S. in 1949 to enter the University of Kansas, from which he graduated (A.B.) in 1953. He remained actively involved in the Greek community of greater Boston throughout his life; he had been president of the American Society for Hellenic Culture and of the United Hellenic-American Organizations of New England.

Avery A. Morton, 1893-1987

Avery A. Morton, Ph.D.'24, professor emeritus of chemistry whose career at M.I.T. spanned nearly 40 years, died on March 25 at the age of 94.

Morton first came to the Institute in 1920 to be instructor in chemistry, following studies at Harvard and the University of Chicago. After receiving his doctorate in organic chemistry, Morton was appointed to the faculty in 1926, rising to the rank of full professor in 1940 when he was also named director of the Research Laboratory of Organic Chemistry. He retired in 1958.

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

Mrs. Orville B. Denison, '11; January 14, 1986; Cornish, Maine.
Lee A. Bailey, '12; May 7, 1987; Fort Lauderdale, Fla.
Levi B. Duff, '14; May 7, 1987; Pittsburgh, Penn.
Everett S. Coldwell, '15; April 23, 1987; Mt. Vernon, N.Y.
James C. Flaherty, '17; April 26, 1987; Dedham, Mass.
Lawrence J. Allen, '18; June 12, 1987; Glendale, Calif.
John L. Riegel, '19; May 1, 1987; Hartsdale, N.Y.
Forest W. Sanders, '20; May 30, 1987; El Paso, Tex.
Philip L. Young, '20; 1987.
Andrew M. Bell, '22; October 26, 1986; Stanford, Ky.
Thomas E. Courtney, '22; February 11, 1987; Indianapolis, Ind.
Arthur B. Craig, '22; March 3, 1987; Santa Monica, Calif.
Chauncey E. Eaton, '22; October 26, 1986; Westmont, Ill.
Ralph E. Hanten, '22; June 1984; Watertown, S.D.
John P. Livadary, '22; April 7, 1987; Balboa Island, Calif.
Evelyn O. McKnight, '22; April 19, 1987; Williamstown, Mass.
Wilbur J. Woodruff, '22; April 25, 1987; Avon, Conn.
Benjamin B. Drisko, '23; May 10, 1987; Camden, Maine.
Dale E. Washburn, '23; May 8, 1987; Rockport, Mass.
William Giddon, '24; March 21, 1987; Brookline, Mass.
Donald B. Jennings, '24; June 13, 1986; Ross, Calif.
Franklin W. McLaren, '25; December 13, 1986; San Mateo, Calif.
William T. Dixon, '26; February 9, 1987; Media, Penn.
Robert T. Connor, '27; March 17, 1987; Fairfield, Conn.
Edwin J. Haertl, '27; March 13, 1985; Pinehurst, N.C.
Harold E.H. Knight, '27; May 1987; Southold, N.Y.
Percy M. Roope, '27; February 26, 1987; Cambria, Calif.
Donald P. Wylie, '27; May 5, 1987; Hanover, N.H.
Max Bearon, '28; May 8, 1987.
Dudley W. Smith, '28; May 13, 1987; Carlsbad, Calif.
Gustave M. Solomons, '28; May 13, 1987; Cambridge, Mass.
Philip S. Taylor, '28; April 14, 1987; Walpole, Mass.
Duncan P. Whittaker, '28; February 19, 1987; Falmouth Foreside, Maine.
John F. Dreyer, '29; December 31, 1986; Cincinnati, Ohio.
Fleming R. Hurt, '29; May 3, 1987; Waynesboro, Va.
Charles T. Abbott, Sr., '20; April 10, 1987; Lexington, Mass.
Stanley G.L. L'Esperance, '30; May 12, 1987; Belmont, Mass.
Charles P. Dreyer, '32; May 16, 1987; South Yarmouth, Mass.
Edward F. Harrington, '32; July 5, 1984; Haverhill, Mass.
Edward J. Bertozzi, '33; March 18, 1987; Pawtucket, R.I.
Robert A. Fuller, '33; March 2, 1987; Portsmouth, Ohio.
Malcolm G. Fisher, '34; May 11, 1987; Jamaica Plain, Mass.
Simon Malkin, '34; December 25, 1985; Malden, Mass.
Roger S. Brookman, '35; April 26, 1987; Sanford, N.C.
Alexander A. Frank, '35; April 25, 1987; Key West, Fla.
Nelson H. Thorp, '35; April 28, 1987; North Port, Fla.
William M. Creasy, '36; March 1987; Pine Bluff, Ark.
George H. Temple, '36; March 15, 1987; Cumberland Center, Maine.
Peter P. Chunko, '37; April 20, 1987; West Islip, N.Y.
Harry D. Crapon, Jr., '37; May 1986; Ocean Springs, Miss.
Samuel Noodleman, '37; June 1983.
Herman A. Speh, '37; August 1986; Huntington, N.Y.
Given A. Brewer, '38; April 26, 1987; Marion, Mass.
Abner A. Towers, '38; March 18, 1987; Atlanta, Ga.
Harlan H. Davis, '40; May 2, 1987; Oakbrook Terrace, Ill.
Marie H. Johnson, '40; March 27, 1986; Princeton, N.J.
John A. Hornbeck, '44; January 30, 1987; St. Simons Island, Ga.
Richard M. Marsh, '44; May 27, 1986; Signal Mountain, Tenn.
George B. Hetrick, Jr., '45; April 28, 1987; Lancaster, Penn.
John R. Anderson, '46; January 22, 1987; Arcadia, Calif.
Barrett B. Brown, '47; December 12, 1986.
Edward M. Dooley, '49; January 30, 1987; Frogmore, S.C.
Dowell J. Howard, Jr., '49; July 1976; Cincinnati, Ohio.
Kenneth A. Young, '49; November 1986; Groton, Mass.
Herbert F. Ayres, '50; May 8, 1987; Brooklyn, N.Y.
Prokopios H. Barrows, '51; May 5, 1987; Wellesley, Mass.
Bruce C. Center, '51; March 21, 1987; Chelmsford, Mass.
Howard F. Rockstrom, '53; December 23, 1986; Carlisle, Mass.
George A. Wallace, Jr., '53; April 16, 1987; Cape Elizabeth, Maine.
Zenon S. Zannetos, '55; May 2, 1987; Weston, Mass.
Robert C. Sprague, Jr., '58; April 1, 1987; Williamstown, Mass.
John B.K. Sur, '59; 1986; Honolulu, Hawaii.
Frank M. Labouisse, Jr., '61; January 4, 1986; New Orleans, La.
Philip J. Scanlon, Jr., '72; October 1984; Braintree, Mass.
Warren K. Muldrow, '87; April 10, 1987; Somerville, Mass.

ALLAN J. GOTTLIEB

I Spy the Fly; But Will Physics Let Me Swat It?

After last month's long introduction, I find myself surprisingly speechless this time. So let's get right to the problems.

Problems

A/S 1. We begin with a bridge problem from Warren Himmelberger in which West must make a contract of 6 hearts against any defense:

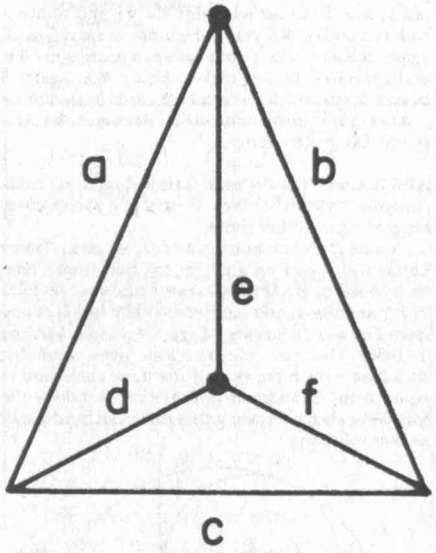
	♠ J 9 5 3 ♥ J 8 2 ♦ 3 ♣ A J 8 6 4	
♠ A K 2 ♥ A K Q 10 9 7 ♦ A K 7 4 ♣		♠ Q 10 6 ♥ 6 5 3 ♦ J 6 5 2 ♣ K Q 7
	♠ 8 7 4 ♥ 4 ♦ Q 10 9 8 ♣ 10 9 5 3 2	

A/S 2. Howard Sard feels that every prime will divide evenly into at least one member of the following sequence: 10, 110, 1110, 11110, ... Is he right?

A/S 3. Michael Gennert wants you to show that using only the operations of addition, subtraction, and multiplication, any three integers can be combined to produce a multiple of 12. Parentheses are permitted. For example, given 9, 11, and 52, we can form
$9 \times 11 \times 52 = 12 \times 429$
and given 15, 17, and 23, we can form
$(23 + 17) \times 15 = 12 \times 50$.

A/S 4. John Prussing's swatter can outaccelerate his flies (at least initially); but is that good enough? A fly is sitting on the positive x-axis a distance h from the origin. A man with a fly swatter is sitting at the origin and spies the fly. At $t = 0$ the fly is pursued by the man, who has a maximum acceleration of unity. The fly evades the swatter by flying out along the x-axis with an acceleration $0.6t$. What is the largest initial separation h for which the swatter can intercept the fly in a finite (positive) time?

A/S 5. Richard Hess and Nob. Yoshigahara want you to find integral values for the lengths a, b, c, d, e, and f in the following diagram.



Speed Department

SD 1. Jim Landau asks what you should do if you are hanging onto a rope for dear life and are almost (but *knot* quite) at the end of your rope.

SD 2. Phelps Meaker has a regular hexagonal basket whose vertical sides are equal in area to $\sqrt{3}$ times that of the bottom. How deep is the basket?

Solutions

APR 1. South is declarer at a six-heart contract. Opening lead: ♠5. Make 12 tricks against best defense:



SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

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	♠ A K 10 4 ♥ A J 10 ♦ A 7 5 ♣ A 5 3	
♠ Q 9 8 5 ♥ 2 ♦ J 9 4 3 2 ♣ Q 9 2		♠ J 3 ♥ Q 9 4 3 ♦ 10 8 6 ♣ J 8 6 5
	♠ 7 6 2 ♥ K 8 7 6 5 ♦ K Q ♣ K 10 4	

This hand occurred at a duplicate bridge club. South was the only declarer to make 12 tricks. In her successful line of play, East made the ♥9 at the end of the hand. After looking at this double-dummy problem, another friend suggested an entirely different approach. In his line, East makes the ♥9 earlier in the play. What are these two successful lines of play?

The following solution is from Timothy Maloney:

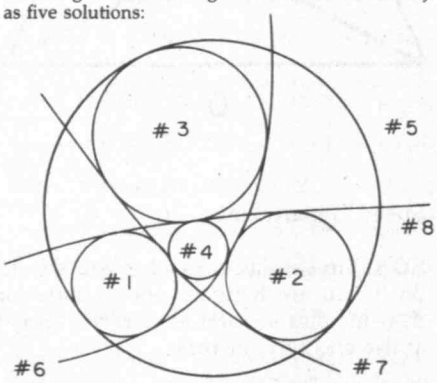
Declarer takes the ♠A in dummy, then leads the J and 10 of trump from dummy. East must cover with the ♥Q, which is covered by the ♥K. South leads out the ♦K and ♦Q, then another heart to the ♥A leaves East with the master ♥9. Declarer discards a spade on the ♦A, wins the ♠K, and when he leads the ♠10 at trick 9, East decides the course of play:

1. East takes the ♥9 and South discards a club. East must return a club and declarer takes two clubs and two remaining trumps for 12 tricks: 5 hearts, 2 spades, 3 diamonds, and 2 clubs.
2. East discards a club and South ruffs with ♥7 or ♥8. He returns to dummy with ♣A and leads his last spade. East can win with his ♥9 and return a club to South's ♣K and last trump, or he can duck again. If East ducks, South ruffs again, wins his ♣K and concedes the last trick to East's ♥9. Again, 5 hearts, 2 spades, 3 diamonds, 2 clubs to declarer.

Also solved by Matthew Fountain and the proposer, Doug Van Patter.

APR 2. Given the circles of different radii, no circle contained within another, construct a fourth circle tangent to the other three.

No one found an exact geometric solution. James Landau enclosed an analytic solution from Coxeter's book *Introduction to Geometry* published by John Wiley and Sons, and Norman Wickstrand sent one from *Tips and Techniques—Engineering Aids*, Volume 2 (1956). This last reference also gives geometric solutions, which are exact if the three circles are of equal radii. In addition, Mr. Wickstrand drew the following sketch showing that there can be as many as five solutions:



1, 2, and 3 are the given circles; 4 is the inscribed circle; 5 is the circumscribed circle; 6, 7, and 8 are approximate arcs indicating how three more circles can be drawn. Circle 8 could be a circle of infinite radius or could be concave up or concave down, as shown.

Finally, the following geometric approximation technique is from Matthew Fountain:

The center of the fourth circle is at distance of q + t, r + t, and s + t from centers of the other three, where q, r, s, and t are the radii of the respective circles. Therefore the center of the fourth circle q − r farther from the center of the first circle than from the center of the second circle and must lie on a hyperbola with foci at these last two centers. Sections of this hyperbola may be plotted to any required degree of accuracy by plotting the locus of the points of intersection of arcs drawn about the centers of the first two circles, the first of each pair of intersecting arcs being q − r greater in radius than the other. A second hyperbola through the center of the fourth circle may be obtained by plotting the points of intersection of arcs drawn about centers of the second and third circles, the first arc of each pair of intersecting arcs being r − s greater in radius than the other. The intersection of these two hyperbolas is the desired center of the fourth circle. It is not necessary to find many points in practice, as one can guide one's progress by assuming that over short sections the hyperbolas are straight lines. I do not believe there is any theoretical way of locating the center of the fourth circle exactly with just straightedge and compass.

Also solved by John Cushnie, John Woolston, Mark Markish, Mary Lindenberg, and the proposer, J. Ruoff.

APR 3. The diagram represents the product of three-digit numbers by two-digit numbers. What were the original problems?

The spacing was not done very well on the first part of this problem. Larry Bell, however, was not deterred and solved the problem that was intended:

We need to make some assumptions about liquid crystal displays. First, any number appearing as three horizontal lines (on a calculator that cannot draw vertical lines) must be either 2, 3, 5, 6, 8, or 9. A number appearing as a blank must be a 1. In the problems given there can be no 4s, 7s, or 0s. Label the digits

```
    A B C
  ×   D E
-----------
V W X Y Z
```

In each answer, Z is blank and is therefore 1. So, C = E = 9. The last two problems are

```
    5 2 9          and          5 6 9
  ×   5 9                     ×   3 9
-----------                 -----------
3 1 2 1 1                   2 2 1 9 1
```

In the first problem, there may be a "typo," since there is no match for X = Z = 1 and V = either 0 or 1. The closest match I could find is

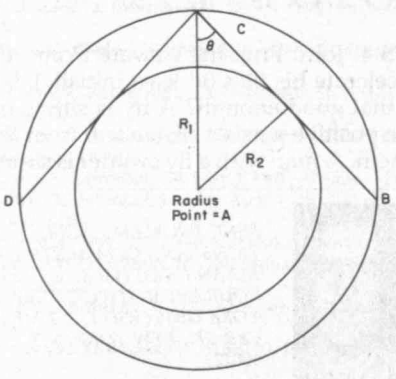
```
    3 5 9
  ×   5 9
-----------
2 1 1 8 1
```

which could be correct if the width of the first space in the first answer was not drawn to scale.

Also solved by Alan Taylor, Dick Robnett, James Landau, John Woolston, Matthew Fountain, Steve Feldman, and the proposer, Nob. Yoshigahara.

APR 4. A star-shaped figure can be drawn with two concentric circles, drawing chords tangent to the inner circle, successively around the outer one until they meet the starting point. How many points, blunt as they may be, result if the inner circle is .66913 of the outer? Compass and straightedge not allowed.

The following solution is from Ken Rosato.



By observation $R_1/R_2 = \sin\theta$. So $\sin\theta = \sin^{-1}(.66913) = 42°00'$. By symmetry, angle ACB = angle ACD = θ, so angle BCD = $2\theta = 84°$. $\overline{BC}$ and $\overline{CD}$ are chords on the star in question, and point C is a typical apex of the star. The supplement of angle BCD will be the deflection angle for each point of the star, and will have a value of $180° - 84° = 96°$. Now for a star to be properly formed, the successive chords must be formed until the first time a new chord falls exactly on an old one. Since a circle has 360°, this condition will be fulfilled when the running total of the deflection angles reaches an integral multiple of 360°. We thus have $n(96°) = k(360°)$, where n is the sought-after number of sides of the star, and k is an integer. Re-arranging gives $n = (360°/96°)k$, which reduces to $n = (15/4)k$. For $k = 1, 2$, or 3, n will not be an integer and the star will not have its proper form. But when $k = 4$, $n = 15$, giving a 15-sided star whose chords circumnavigate the larger circle exactly 4 times.

Also solved by Alan Hodgkinson, Alan Taylor, Daniel Morgan, Dick Robnett, Frederick Furland, James Landau, John Prussing, John Woolston, Larry Bell, Matthew Fountain, Steve Feldman, and the proposer, Phelps Meaker.

APR 5. Mr. Brown asked Mr. Smith to perform the following operations in the order named, without Brown's being able to see Smith's work:
(a) Write any positive integer, preferably of two digits to save labor on the part of Smith.
(b) Multiply this number by the next highest integer.
(c) Multiply the result of (b) by 225.
(d) Add 56 to the result of (c).
(e) Tell Brown all the result of (d) except the two right-hand digits.
Smith gave 4064 in response to the request in (e), whereupon Brown, after a moment's computation, informed Smith that his result after step (d) was 406406 and that the number he originally chose was 42. Smith confirmed these statements. How did Brown reach his conclusion?

Our last solution is from Sidney Shapiro:
For integer values of x, the computed number $(x)(x+1)(225) + 56$ ends in either 06 or 56. Given all but the last two digits of the computed number, Mr. Brown proceeded as follows:
a. He appended two zeros to the all-but-last-two-digits number; call that number P.
b. He let $Q = P+6$
c. He solved the quadratic equation
$225x^2 + 225x + 56 = Q$
d. For x equal to an integer, x is the value of the selected number and the last two digits of the computed number are 06.
e. If x is not an integer, Mr. Brown let $Q = P+56$ and repeated step c. The resulting integer value of x is the selected number and the last two digits of the computed number are 56.
For example, if the all-but-last-two-digits are 2678:
a. P = 267800
b. Q = 267806
c. x = 34 and the computed number is 267806.
If the all-but-last-two-digits are 2835, then:
a. P = 283500
b. Q = 283506
c. x is not an integer
d. Setting Q = 283556, x = 35 and the computed number is 283556.

Also solved by Daniel Morgan, Dick Robnett, Frederick Furland, James Landau, John Cushnie, Larry Bell, Mary Lindenberg, Matthew Fountain, and Michael Jung.

Better Late Than Never

JAN 2. Naomi Markovitz has responded.

JAN 3. Naomi Markovitz has responded.

FEB 3. Naomi Markovitz and Kelly Woods have responded.

FEB 4. Kelly Woods has responded.

Proposers' Solutions to Speed Problems

SD 1. Holding onto the rope with your legs and one hand, use the other hand to tie a bowline in the rope. Make sure that the loop of the bowline is about a foot or two across. Now you can sit comfortably and safely in the loop until you are rescued. Legend has it that someone saved himself from the burning Hindenburg by using this trick.

SD 2. Three quarters of one of the flats of the hexagon.

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ACCURACY V. ADVOCACY

Expert Testimony Before the Bench

BY MICHAEL J. SAKS

Although the U.S. legal process can contort technical testimony, the adversary system is our best option.

In 1980, after being injured while using a wooden stepladder, Joseph Calvanese sued the manufacturer, W. W. Babcock Co., in Hampden District Court in Massachusetts. Calvanese had to be hospitalized after the left rear leg of the stepladder he was working on cracked near a steel rivet and came apart. Calvanese's engineering expert testified that the accident resulted from defective manufacturing of the ladder. The manufacturer's engineering expert testified that the ladder's construction conformed with industry standards, and that the accident most likely occurred because the ladder was improperly loaded.

If such differences of opinion can arise in the case of an ordinary ladder, imagine the opportunity for debate in cases involving aircraft, computers, buildings, and bridges. With the law increasingly reliant on scientific and technical expert testimony, our courts face a troubling dilemma. To reach a rational decision they need help from experts. But some observers have become skeptical about whether expert witnesses can provide that help impartially.

Even lawyers sometimes worry about the system. Last year a friend of mine who is a lawyer was representing a pharmaceutical company that believed its headache remedy was superior to a competitor's. The first company had sued the latter because it had advertised, based on several experiments involving small numbers of headache sufferers, that its formula was just as good. Experts hired by my friend assured him that these separate studies could be combined and thereby reveal that the products differed significantly. But my friend feared that in the experts' eagerness to please, they might not be telling him the unvarnished truth. Concerned about his *own* experts, he privately checked the ideas with statistical experts not involved in the case.

In this case, the hired experts had not been pushing the truth too far. But too often, as my friend recognized, the zealous presentation of views that the adversary process encourages may introduce distortions. Influenced by a lawyer, experts may interpret scientific information more broadly than they normally would.

As an alternative to our adversary system, most of the world uses the Napoleonic, or Continental, system. This mandates that judges play a much more active role in investigating the facts and developing a case. The judges have a staff of their own investigators and call on their own expert witnesses. The danger with this system is that judges may have long-standing biases that won't be challenged, and may reach premature conclusions that will not be tested by further digging for the facts.

The adversary process used in the United States does not work as well as we might wish, but no system is better suited to assist a judge or jury in weighing competing versions of truth. As George Bernard Shaw once caustically observed, "The theory of the adversary system is that if you set two liars to exposing each other, eventually the truth will come out."

The procedure could be improved if experts better understood their role and learned to withstand the pressures of the adversary system. Professional associations could support their members in this effort.

ILLUSTRATIONS: SALLY WERN COMPORT

And the rigor of legal decision making would be generally improved if everyone recognized the demands on experts and the judges or juries who consider their testimony.

Experts: Engineers and Drug Addicts

Many of us think of an "expert" as belonging to the uppermost fraction of a profession. In the legal process, the category of experts is much broader. It includes anyone whose knowledge of a subject extends beyond that of the average juror. Everyone could qualify as an expert witness on something. Engineers and automobile mechanics, farmers and accountants, drug addicts and toxicologists have all qualified as expert witnesses.

The courts' test for deciding if you are an expert is fairly mechanical. If a technical issue before the court is routinely addressed by a recognized field, you need only show you are a member of that field by "knowledge, skill, experience, training, or education," according to the Federal Rules of Evidence (the code that governs the admissability of evidence in federal courts). In practice, if you have the proper label through education or employment, you will pass the test. If the issue is whether a certain white powder is cocaine, a person with a B.S. in chemistry who works for a laboratory that tests for cocaine is an expert. If the question is whether the materials and methods used to anchor a steel structure to a concrete foundation should have been able to withstand winds of a certain velocity, the expert could be any of a large number of civil engineers.

Expert witnesses can be either amateurs or professionals in court work. Amateurs become involved in lawsuits when something they are working on leads to litigation or they are sought out to serve in a case. Professionals divide into two categories: "institutional"— chemists, document examiners, toxicologists, and other forensic scientists who are employed full-time by police labs—and "entrepreneurial"— those who have independent practices serving as expert witnesses. The proportion of entrepreneurial professionals is said to be increasing, although no one knows how many there are.

Is one of these groups likely to be the most competent and honest? As far as I am aware, no one has any hard evidence on the subject, and speculation could lead in any direction. Amateur experts might be more up-to-date and practiced in their fields, and be more independent and have less of a stake in keeping lawyers happy. However, since they are subjected to adversarial scrutiny least often, amateurs may make the most malleable experts. They have the least experience in managing the lawyers who try to manage them.

The institutional professionals may be the most effective because they spend more time serving as experts and know their way around a trial. Or they may be the worst because they have the least independence. If ever experts belonged to a team, these are they.

Could the entrepreneurial professionals be in the best position to call the shots? They work for themselves and have plenty of experience in the adversary process. But they are the hired guns within the expert community, the most financially dependent upon the process and therefore the most committed to keeping clients happy.

The Lawyer's Influence

Unfortunately, each category of experts is vulnerable to the possibly distorting influence of lawyers. Long before the expert and lawyer arrive in court, a bond has formed between them. The influence of the lawyer is considerable. He or she may authorize a limited budget for analyzing the evidence and restrict the information provided to experts about the case. The attorney expects help and cooperation from experts, who know that the lawyer could hire someone else. The question is how far they are willing to be drawn out onto the forensic limb.

One prominent trial judge in Massachusetts likens the process to a seduction. The lawyer attempts to convince the experts to go as far as possible, and the experts try to resist the temptation to acquiesce. It is the lawyer's job to test the limits and the expert's job to set those limits.

But sometimes the experts go too far. Presiding at a Canadian trial that concerned the toxicity of the chemical dioxin, Nova Scotia Supreme Court Justice D. Merlin Nunn said this about the experts in the case: "While I do not doubt the zeal of many of the

MICHAEL J. SAKS, visiting professor at the University of Iowa College of Law, is a social psychologist who studies legal policy. He is co-author of The Use of Scientific Evidence in Litigation *(1983), published by The National Center for State Courts.*

plaintiffs' scientific witnesses or their ability, some seemed at many times to be protagonists defending a position, thereby losing some of their objectivity."

In contrast to what attorneys may want, experts' professional colleagues expect them to give a competent and dignified account of the field without going beyond its limits. These expectations are sometimes expressed in a code of ethics. For example, the National Society of Professional Engineers (NSPE) states: "Engineers shall issue public statements only in an objective and truthful manner. Engineers shall be objective and truthful in professional reports, statements, or testimony. They shall include all relevant and pertinent information in such reports, statements, or testimony."



Lawyers attempt to convince experts to go as far as possible.

The expectations vary from field to field. Some subject areas are more rigorous, demanding, and cohesive, while others are more ambitious and looser in their standards and leave members more to their own judgment. Some professional organizations and fields go to more trouble to make sure that their members know and live up to the expectations.

Whatever experts' perceptions of the expectations of their colleagues, the likelihood that any sanctions will be applied against those who overstep their bounds is tiny. This fact was clear in a 1983 study I did with Richard Van Duizend, then an attorney with the National Center for State Courts. We contacted the ethics and discipline committees of professional associations such as the NSPE, the American Academy of Forensic Science, and the American Medical Association. We found that virtually no actions had been taken against members who had misrepresented the field's knowledge or drawn insupportable conclusions on behalf of one party as expert witnesses. Complaints that did surface were typically brought by attorneys complaining that the experts they hired had misrepresented their educational or professional credentials. Professional associations are in business to insure their members' well-being more than to police them.

Checks on whether experts' assertions are safely within their expertise are provided by a knowledgeable opposing attorney, aided by that side's experts. After a federal trial in Dallas, a statistician who had been hired as an expert described the importance that both sides play in constructing the whole story. It is, he explained, as if the factual picture of the case presented to the court is a large two-dimensional matrix that has to be filled in cell by cell. Each side fills in the cells that help its cause, leaving blank the other cells. Only if both sides do their job well will the court, by the end of the trial, have the full picture.

What Evidence Is Admissible?

The picture of a case can be skewed by what is permitted as expert testimony. A judge is supposed to prevent the court from hearing information that lacks relevance or trustworthiness. Yet this can be difficult. Suppose new knowledge from a field with which you are not personally familiar were given to you. How would you assess its validity? This is the problem judges often face, especially when presented with what the law calls "novel scientific evidence." The decisions they must make are governed by one of two tests. Unfortunately, neither test is without problems.

The standard favored by most courts is called the Frye Test, after the 1923 case of *Frye v. United*



Thomas Barefoot was executed after a jury relied on testimony from two psychiatrists and decided he was dangerous.

States. In that case the U.S. Circuit Court of Appeals for the District of Columbia refused to allow a defendant to offer lie detector evidence that might absolve him of guilt. But the court decided that the technology from which the expert testimony was deduced had not gained "general acceptance."

The Frye test requires a judge to determine the status of an idea within a field. In a 1983 case a federal circuit court held that "the proper inquiry is not what the court deems reliable, but what experts in the relevant discipline deem it to be." On the surface that idea sounds comforting. Courts will accept expert testimony only if experts in the field have first accepted the scientific principle or application on which the testimony is based. Who is in a better position to decide what a field of knowledge should include?

Carried further, however, the idea is not so reassuring. All the court usually has to go on is what the experts in court say their colleagues think. Of course, the opposing side could have its experts point out if the truth were stretched, but then the first side could refute that testimony. Even if a court could count scientific noses, the Frye test would not be impressively rational. The law's reliance on experts to decide what is generally accepted is a remarkable show of deference to scientific and technical people. In virtually all other situations the courts reserve such judgments for themselves.

The Frye test creates several problems. The procedure does not include guidelines for defining a given field's boundaries. Nor does the test set standards that fields must adhere to for their judgments to be deemed sufficient. And it does not suggest who should resolve such uncertainties: the court, which does not have the background to know, or the disciplines, which are often waging turf battles.

Consider handwriting identification by document examiners. Is that a scientific enterprise or is it more akin to astrology? Do you ask document examiners? And who decided that astrology is a sham? Surely the astrologers weren't consulted.

Had a recent case involving handwriting analysis not been settled out of court, these questions might have been answered. For more than a century courts have allowed document examiners to testify on whether two signatures came from the same person. In the 1985 case of the "Mayflower madame" in New York City, those experts' expertise was challenged. Sydney Biddle Barrows, a member of a prominent family that came to America on the Mayflower, was accused of maintaining a house of prostitution. Some of the major evidence against her consisted of a handwritten directory of customers. The prosecution wanted to call a handwriting expert who would testify that the defendant's handwriting matched that in the directory. The defense challenged the admissibility of this testimony on the grounds that no studies had ever shown that such experts can do what they claim.

A plea bargain favorable to the defendant spared handwriting analysis its most probing examination. Had the case gone to trial, the court would have had to consider the validity of this common kind of expert testimony.

Another problem with the Frye test is that knowledge from more rigorous fields enters the courts more slowly than knowledge from less rigorous disciplines. For example, compare two subdisciplines of psychology. Clinical psychology conducts relatively little scrutiny before accepting claims that certain phenomena and knowledge are true. Since the

Frye test requires only that the evidence be generally accepted within a field, less controversial though weaker information is, ironically, the more readily accepted.

By contrast, the courts quibble about admitting testimony from the much more rigorous field of experimental psychology. A battle has raged for more than a decade as to whether experimental psychologists can testify about the validity of eyewitness evidence in lawsuits. For the past 100 years such psychologists have conducted careful experiments on how visual identification is affected by variables ranging from the passage of time to the conditions under which the observation was made. Because specialists in this subfield argue interminably about measurement, control, and data analysis, many courts have decided not to admit such "novel" scientific testimony.

Meanwhile, the testimony of clinical psychologists and psychiatrists, who often intuit answers, is accepted by the courts every day. The U.S. Supreme Court acknowledged in 1983 that psychiatric testimony predicting dangerous behavior is wrong at least twice as often as it is right, yet the Court refused to stop admitting such testimony. The case concerned Thomas Barefoot, who had been convicted of murder. A lower court had sentenced him to death after a Texas jury, relying on testimony from two psychiatrists, decided that he was dangerous.

The Supreme Court also recognized the American Psychiatric Association's official position that such predictions were beyond the expertise of psychiatry. (These facts had not been presented in the lower court because Barefoot's lawyer apparently didn't know them.) Yet none of this put the testimony below the threshold of admissibility, even on a life-and-death question. "Neither [the lawyers for] Barefoot nor the [American Psychiatric] Association suggests that psychiatrists are always wrong with respect to future dangerousness, only most of the time," stated the majority opinion of the Supreme Court. Barefoot was later executed.

Evidence based on the forensic sciences, including ballistics, document examination, and fingerprint identification, is also widely admitted into the courtroom. Yet few universities have forensic-science departments, and research is sparse compared with other fields. Thus, the little controversy within forensic science is deceptive. Were the field to become a vigorous scientific testing ground, the resulting controversy would raise doubts in judges' minds about the validity of generally accepted procedures.

Once testimony from a particular category of expert becomes common, that kind of witness is no longer subject to such scrutiny. The dangers this can entail were demonstrated with chilling clarity in a study by Joseph Peterson, Ellen Fabricant, and Kenneth Field, a team of forensic scientists doing research supported by the National Institute of Justice, a research arm of the U.S. Justice Department. The team sent sample packages of hair, drugs, handwriting, blood, bullets, and similar sorts of routine physical evidence to more than 200 police labs throughout the United States and Canada. The researchers asked the forensic scientists to perform their usual tests and send their standard reports.

The results showed a wide range in competence, with some materials much more likely to be identified accurately than others. Some of the worst performances: 71 percent of the labs erred in identifying a blood sample; 68 percent failed to determine that a hair sample was from a cow, not a person; 51 percent failed to match paint chips; and 14 percent even misnamed or misclassified firearms.

Instead of using the Frye test to decide whether evidence is admissible, a growing number of courts are using a method called the relevancy test. This standard grows out of the 1975 Federal Rules of Evidence, which require that scientific evidence need be "relevant" only in the eyes of the court, not the field, to be admissible. The court focuses on what expert witnesses say is the substance of the information, not what they claim other scientists think. Under this system lawyers and their experts must fight about the content of a field's knowledge.

In concept this solution reduces a scientific field's power to control the evidence for a court of law. But law professor Edward J. Imwinkelried of the University of California at Davis argues that in practice the relevancy test makes matters worse by transferring power from a field to its individual members. Instead of asking an expert witness to show that *many* people find the knowledge valid, the expert simply presents his or her case regarding the evidence. This approach brings us back to the question of how courts can best assess scientific information, even when led by intelligent, thoughtful judges. Can trial courts, with their emphasis on verbal testimony, comprehend and evaluate complex empirical and quantitative technological knowledge?



Suspicious of expert witnesses called by lawyers, judges could appoint their own experts.

Facts Don't Dictate Legal Decisions

Another problem confronting the use of expert testimony is that the truth is merely instrumental in helping to resolve a legal dispute. The underlying facts are less important than the law's larger job—to bring disputes to a tolerable resolution with fairness and justice. Scientific evidence plays a part but does not dictate the outcome.

Consider the case of *Berry v. Chaplin*, a 1946 California paternity suit brought against Charlie Chaplin. Although blood-group evidence showed that Chaplin could not have sired the child, a jury found him to be the father and the trial court ordered Chaplin to pay hospital expenses and child support. Chaplin appealed the decision, arguing that the verdict was contrary to the scientific evidence. But the Court of Appeals of California upheld the jury's verdict.

To those who focus upon scientific evidence as the arbiter of truth, the case seems ludicrous. But scientific validity was not all that was at issue. Another concern was the decision-making process. If the blood test in the Chaplin case had been treated as conclusive, it and not the court would have decided on financial responsibility for a child born out of wedlock. The jury may have doubted the manner in which the blood test was carried out, the underlying science, or the honesty of the expert witnesses. (Perhaps Chaplin paid them for the "right" conclusions.) Or perhaps the evidence was not presented clearly enough for the jury to understand.

The jury's notions of justice may also have affected the outcome. The evidence showed that the wealthy movie star had been sleeping with a naive young woman of modest means. She became responsible for a newborn and was stuck with expenses while he continued his glamorous life. Perhaps the jurors thought that the biological connection was less critical than his exploitation of the woman and the fact that he easily *could* have been the father. Or they may have felt that it was time for him to "pay" for the numerous affairs he was believed to have had.

The jury had the power to weigh the evidence as it saw fit when making its decision. As the appeals court in the Chaplin case concluded, "Expert testimony is to be given the weight to which it appears in each case to be justly entitled."

Similarly, scientific information did not determine the outcome in a 1980 Indiana case involving a tire blowout. The plaintiff, Phil Roque, sued Sears, the manufacturer, claiming that the tire must have been defective. The only technical evidence introduced at the trial came from Sears engineering experts, whose evidence established that road hazards caused the blowout. The jury nevertheless found for the plaintiff. The verdict was upheld by the court of appeals, which said the jury was free to evaluate the evidence as it saw fit, and might draw different inferences from the evidence than the defendants thought it should.

Protecting Against Errors

Despite all these difficulties, expert testimony is an important contribution to our system of justice and our society. Even if juries and judges make mistakes now and then, what is the alternative? A few mistakes cost society less than a decision to overthrow a dispute-resolution system that has worked fairly well for 700 years. Those of us with a fondness for a narrow, technical basis for legal decisions will inev-

itably be disappointed with this system. A technocracy would place more emphasis on scientific outcomes. Yet even in a technocracy, many technical findings would be debatable. In a democratic legal system, other values come into play. Justice does not turn on the truth of any one fact.

The alternative to expert witnesses is to invite the courts to guess at the right answer to technical questions. That appeals to no one. The real issue, then, is how to improve the quality of legal decision making and the information available to the courts. As already mentioned, one solution is more vigorous scrutiny, by opposing lawyers, of experts and what they say. Several other devices are already on the books but are rarely used. For example, the court can call its own expert witnesses in addition to those called by the parties' attorneys. In non-jury trials the court can appoint an "advisory jury" that can consist entirely of experts, if the judge wishes. Or the court can appoint special "masters" who are experts to hear motions or evidence before the trial. These techniques can reduce the number of scientific issues left for the judge or jury to cope with at the trial.

In our study of the use of scientific evidence in litigation, Richard Van Duizend and I found that the judges we interviewed were almost uniformly suspicious of expert witnesses. But the judges made astonishingly little use of their power to appoint their own experts or to employ other accepted alternatives. Why? Two answers are apparent. Money has not been available to the courts to pay for some of these techniques. And judges are uncomfortable trying unconventional procedures.

Other systemic solutions are needed. The courts might experiment with creating panels of court-approved experts from which attorneys would have to choose. Or "science courts" could hear certain cases. These tribunals would be composed of judges who would be practicing scientists and who would hear empirical evidence bearing on particular scientific techniques. The judges would decide what would be admissible testimony in trial courts. A concern about this technique, of course, is that the judges would have biases depending on their training and schools of thought. "Science judges" could also hear certain cases. Like patent court judges, these persons would have technical training and would be assigned cases with large doses of scientific or engineering content.

Such solutions are unlikely to be embraced because they inevitably undercut the adversary process that is the foundation of the American legal system. By tradition and widely accepted theory, justice is believed to be served best when the parties control the development and presentation of their cases. Presumably, science judges would "know too much"—they wouldn't be passive umpires.

Since structural reform is unlikely, at least in the immediate future, the most realistic solutions concerning expert testimony are tactical. Experts should learn the basic rules of evidence and procedure and their professional organizations' canons of ethics. They should know the rules of the game into which they usually wander naively, not be introduced to them by a lawyer who has no incentive to educate and every incentive to control.

Experts should obtain as many details as possible about a case and their role in it. They should find out the scientific issues. They should learn to stand up to lawyers who try to lure them further than they should go. And they should learn to give accurate, two-sided presentations in court, recognizing that they are witnesses, not advocates.

Experts will develop such awareness only if they want to take greater control of their role as witnesses. It is hard to imagine that professional organizations could require such knowledge, since these groups don't like to police their members.

Experts who talk candidly and set limits often discover that, with some negotiation, lawyers will accept those restrictions. At least that has been my experience as an expert witness. In fact, as case preparation proceeds, the power in the negotiation shifts to the expert upon whom the lawyer depends.

One reason too few experts behave independently is that they usually testify alone, without social or professional support. Professional associations could help by providing continuing education, telephone clearinghouses that put callers in touch with colleagues, and sessions at professional meetings to help members learn the rules of the legal game.

The adversary system receives support when it works as well as theory suggests it should. This typically happens when the parties in a dispute are well-heeled and therefore have adequate time and talent to prepare their cases thoroughly. Even if the parties have limited finances, the system can work. But this depends, in part, upon expert witnesses who fully understand and fulfill their role. □



Can We Close the Ozone Hole?

BY F. SHERWOOD ROWLAND

Thirty-one nations could soon agree to limit the use of chemicals that are destroying stratospheric ozone. Industry is finding substitutes for these compounds, once described as irreplaceable.

THIS September, 31 industrialized nations are meeting in Montreal to complete a major environmental agreement. They will prepare the final draft of a protocol regulating chemicals that are depleting the upper atmosphere's ozone. The protocol caps a tremendous flurry of regulatory activity that has occurred during 1986 and 1987. The driving force behind this burst of activity, which followed years of neglect, is the 1985 disclosure of a "hole" the size of the continental United States in the ozone layer over Antarctica. This discovery means that ozone depletion is no longer a hypothesis. It is real.

Concern about stratospheric ozone—the substance that protects life on Earth from the damaging part of the sun's ultraviolet radiation—arose in the early 1970s. For about 40 years, industrial activities had been releasing chlorofluorocarbon (CFC) gases into the atmosphere. These compounds came to be used for everything from air conditioning automobiles to cleaning electronics components. In 1974 Mario Molina, a postdoctoral associate, and I published a theory indicating that several members of the CFC family were essentially inert in the lower atmosphere but could be destroyed in the upper atmosphere by ultraviolet radiation. Because chlorine atoms attack ozone vigorously, the destruction of chlorinated compounds high in the atmosphere could result in decreased ozone concentration. The finding implied that these chemicals could be seriously affecting the Earth's ozone shield.

Ozone absorbs much but not all of the damaging ultraviolet radiation from the sun. The radiation that passes through is the primary cause of human skin cancer, has destructive effects on many other plant and animal species, and is suspected of affecting the human immune system. A decrease in atmospheric ozone would allow more radiation to reach the Earth's surface, thus increasing these negative biological effects. CFCs also contribute to the greenhouse effect, which warms the Earth's surface. In coming decades, increased warming from human activities such as CFC production could lead to worldwide

ILLUSTRATION: SUSAN LeVAN

changes in temperature, wind, and rainfall, and to a substantial rise in sea level. This could result in problems ranging from significantly lower crop levels to major flooding along shorelines, where many of the largest cities are located.

To prevent extensive further ozone depletion, substitutes will have to be developed for products that rely on the ubiquitous CFC family. Alternatives already exist for many CFC uses, and research will no doubt yield substitutes for almost all the rest. Substitutions are critical, for it is of the utmost importance that *all* countries significantly reduce the amount of CFC they release in the atmosphere.

Ozone's Effect on Radiation

Ozone—a three-atom modification (O_3) of the molecular oxygen (O_2) that we breathe—plays a critical role in the radiation balance of Earth. While it accounts for only about 3 parts per 10 million of the atmosphere, ozone absorbs much ultraviolet radiation, especially in the upper stratosphere, and indirectly converts it to heat.

But the radiation balance is being upset by the industrial CFC compounds, which do not exist in nature. Composed of the elements carbon, chlorine, and fluorine, they were first synthesized in the 1920s, and continued R&D over the next half century led to their present technological importance. Today the gases CFC 12 and CFC 22 are used as the chilling agents in refrigerators and air conditioners. The expansion of CFC 11 is the key to the foaming process for both soft foams and rigid polyurethane, which is used in products ranging from fast-food containers to insulation. A mixture of CFC 11 and CFC 12 is widely used as a propellant in aerosols. And CFC 113 is employed to clean electronic components because of its ability to penetrate crevices and dissolve grease.

From small beginnings in the 1930s and 1940s, U.S. use of CFC 12 and CFC 11—the most common CFC compounds today—grew rapidly after World War II. Production increased by about 10 percent annually for almost three decades, with European production levels showing similar growth a few years later. Today the United States is responsible for about one-third of the world CFC production, with major production also in West Germany, Japan, France, Great Britain, and Italy.

About 85 percent of all CFC 12 and CFC 11 ever manufactured has been released to the atmosphere. Since 1975, 650,000 to 750,000 tons of these compounds have been released annually, with the yearly total of all CFCs now more than 1 million tons. The total atmospheric content of all organochlorine compounds has mushroomed in the past 30 years from about 0.7 parts per billion to more than 3.5 parts per billion. (Part of this increase comes from the cleaning solvents carbon tetrachloride and methylchloroform.) The level of organic chlorine continues to grow by more than 1 part per billion each decade.

The amount of chlorine is significant because that is the element responsible for depleting ozone in the stratosphere. It does this in a chain reaction in which each chlorine atom can destroy tens of thousands of ozone molecules. The process begins when CFCs and other gaseous organic chemicals drift up to the midstratosphere, where they absorb high-energy ultraviolet radiation and decompose into chlorine atoms and other molecular fragments. For example, CFC 12, for which the chemical formula is CCl_2F_2, undergoes the following reaction:

$$CCl_2F_2 + \text{ultraviolet radiation} \rightarrow Cl + CClF_2$$

The single chlorine atom, Cl, is very reactive and within one or two seconds combines with an ozone molecule to form a chlorine monoxide molecule (ClO) and molecular oxygen:

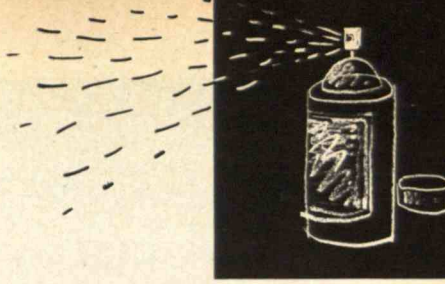
$$Cl + O_3 \rightarrow ClO + O_2$$

The chlorine monoxide molecule left by this step is also quite reactive. After another minute or two, this compound combines with atomic oxygen in the stratosphere to release another oxygen molecule and more atomic chlorine:

$$ClO + O \rightarrow Cl + O_2$$

The newly released chlorine atom then reacts again with ozone, and the process repeats itself. (Incidentally, the Cl atom from the $CClF_2$ fragment is also soon released and initiates its own chain of reactions, breaking down more ozone.) The final two steps can be repeated perhaps 1,000 times—destroy-

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Even if all CFC use stopped today, ozone breakdown would continue for at least a century.

ing ozone in every cycle—until the chain reaction (designated the ClO_x chain) is interrupted by competitive reactions with other atmospheric molecules such as nitrogen dioxide. The new reaction forms a molecule that acts as a "reservoir" for the chlorine for several hours to two or three days. For example, chlorine may combine with nitrogen dioxide to form chlorine nitrate. This reaction occurs regularly, and takes over at night when sunlight is no longer releasing the atomic oxygen needed for the ClO_x chain. But this reservoir molecule is destroyed by the next day's ultraviolet light. This reaction releases the chlorine, which starts destroying ozone again in another ClO_x chain.

The interchange between the ClO_x chain and the temporary reservoirs can occur 50 to 200 times, with each chain cycling about 1,000 times on the average. A chlorine atom that shuttles back and forth between temporary reservoirs and the reactive ClO_x chain can therefore break down about 100,000 molecules of ozone. The process ends when one of the reservoir molecules, usually hydrogen chloride, diffuses down to the troposphere and is removed by rain.

A similar chain reaction occurs with brominated fluorocarbons, which are most commonly used in fire extinguishers. These compounds have bromine atoms attached to carbon atoms. Atomic bromine is even more efficient than chlorine at destroying ozone. Fortunately, these compounds are much less widely used than CFCs.

Even if all CFC use were to stop today, ozone breakdown would continue for at least another century because several of the organic chlorine compounds persist for many decades in the atmosphere. These compounds are not affected by common removal processes such as rainout, oxidation, and decomposition by visible light. This means that most of the CFC 11 and CFC 12—which have about 75-year and 120-year lifetimes, respectively—is still present in the atmosphere in unchanged chemical form. Moreover, even if all CFC production were halted, the maximum level of ozone depletion would not occur for another decade or two. This is because 10 to 15 percent of the molecules already made has not yet been released to the atmosphere, and because much of the recent release has not yet penetrated to the stratosphere.

The theory that CFCs persist unchanged in the troposphere was hotly disputed for almost a decade after it was first proposed in 1974. But none of the suggested methods of CFC destruction near the Earth's surface—from decomposing on Sahara sand under the bright sun to freezing into Antarctic snow—have proven significant. CFC molecules are disappearing from the atmosphere only at the rate expected for stratospheric loss.

Raising the Earth's Temperature

As CFC molecules diffuse randomly in the troposphere, they contribute significantly to the greenhouse effect. It may seem surprising that the greenhouse effects from yearly CFC increases are not completely swamped by the growing amounts of carbon dioxide (CO_2). The atmospheric concentration of CO_2, a by-product of fossil-fuel consumption and the main contributor to the greenhouse effect, is increasing at least 100 times faster than that of any other greenhouse gas. But CO_2, which now averages about 345 parts per million in the atmosphere, already absorbs almost all the radiation it can. Each kind of molecule intercepts radiation only of certain wavelengths and lets the others pass undisturbed.

CFC 12 and CFC 11 absorb radiation of different wavelengths from that blanked out by CO_2 and the other major greenhouse gases—ozone and water vapor. Because CFC 12 and CFC 11 are still relatively scarce, added quantities of either compound intercept radiation at a high efficiency per molecule. Because concentrations of CFC 12 and CFC 11 are roughly 1 million times smaller than those of carbon dioxide, their incremental effect is more important than that of CO_2. Each CFC molecule can intercept about 15,000 times more infrared radiation in the troposphere than each added molecule of CO_2.

Several other compounds whose atmospheric concentrations are growing because of human activities also contribute to the greenhouse effect. These include methane (released from flooded rice paddies, stomachs of cattle, and swamps), nitrous oxide (a by-product of fossil-fuel use as well as microbial processes), and perfluorocarbons (such as carbon tetrafluoride, an aluminum-processing by-product). The combined effect of these gases, plus the CFCs, is such that—should their concentrations continue growing at present rates—they will soon be contributing about as much to the Earth's warming as the increasing concentrations of carbon dioxide. The average global temperatures may rise by 3° C (plus or minus 1.5°) by the middle of the next century, com-

CFC 12 depletes stratospheric ozone after it breaks down into $CClF_2$ and chlorine in the presence of ultraviolet radiation from the sun. The chlorine combines with ozone to form molecular oxygen and chlorine monoxide, which reacts with atomic oxygen and produces more molecular oxygen and chlorine. A chain reaction develops as the chlorine combines with another ozone molecule.

pared with the observed 0.5° increase during the past century.

The Antarctic Ozone Hole

In the early 1970s, concern about ozone depletion stemmed from scientists' realization that high-flying supersonic airplanes would release nitrogen oxides into the stratosphere. These can deplete ozone in a chain reaction similar to the ClO_x chain. This problem remains only a potential threat because just a handful of the planes has been built.

But the ability of chlorofluorocarbons to destroy ozone, first postulated several years later, has been demonstrated in the atmosphere. Information about the dramatic losses over Antarctica since about 1977 was not published until 1985. Ironically, the recorded dips in ozone levels were so large that several research groups—including the British Antarctic Survey team, NASA, and the U.S. National Oceanic and Atmospheric Administration—were reluctant to believe their own findings. Because other groups had not yet reported low ozone levels, each team withheld its report and checked for instrument failures and other problems.

Finally, the British group announced in May 1985 that a massive decrease in ozone concentrations over Antarctica had been occurring in September and October—Antarctic springtime—for the past eight years. This loss, recorded at the British Antarctic station at Halley Bay, was such that the average October concentration of ozone in 1984 was less than 200 parts per billion. By comparison, the October concentration from 1957 through 1973 was about 320 parts per billion. Almost 40 percent less ozone was recorded in 1984 than was routinely observed 20 years earlier.

The ozone losses have been confirmed by balloon-borne instruments sent aloft by Japan in 1982 and by the United States last year, and by the U.S. satellite *Nimbus 7*, which has been measuring ozone concentrations over the entire globe since 1978.

Ozone concentrations over Antarctica begin to decline with the first sunlight of spring in late August. One-third to one-half of the ozone disappears during September—with some air parcels showing losses of up to 90 percent. The area of loss is roughly the size of the continental United States, and is called a "hole" because it often shows sharp concentration gradients. The ozone loss effectively stops by mid-October, and strong air circulation from the temperate zone north of Antarctica soon causes the hole to dissipate. Yet even during the sunlit months the average amount of ozone over Antarctica appears to be somewhat less than in the 1960s.

Three types of theories have been proposed to explain the massive ozone hole. Some NASA scientists have postulated that it is a chemical response to the 1980 peaking of the 11-year solar sunspot cycle. These scientists have theorized that solar activity caused nitrogen oxides to form and these then reacted to deplete atmospheric ozone.

Other scientists focus on a meteorological cause, proposing that the missing ozone has been transported elsewhere. This might occur if ozone-poor tropospheric air moved up into the stratosphere. Some scientists link the ozone loss to horizontal winds. They refer to the fact that the average ozone concentration in the large area south of 45° South latitude—which cuts across lower Chile and Argentina—appeared to remain constant from August through November each year from 1980 to 1982.

Finally, the British scientists at Halley Bay have drawn a link between the ozone loss and the rapidly increasing concentrations of CFC 11 and CFC 12 in the atmosphere. They postulated that ozone is destroyed by atmospheric chlorine compounds as they come under the influence of the very special Antarctic weather patterns. Several other research groups have elaborated on this theory with additional concepts of chlorine chemistry.

The first two theories have not held up. The sunspot-cycle explanation fails on two critical points. First, violent activity on the solar surface peaked three times during the Halley Bay measurements (in 1958, 1969, and 1980), but ozone loss was observed only after the 1980 peak. Second, the postulated influx of nitrogen oxides expected from sunspot activity has not been found. In fact, observations during September 1986 revealed extremely low concentrations of these compounds.

Nor does the evidence reveal a rise of ozone-poor tropospheric air. Concentrations of two important tropospheric gases, methane and nitrous oxide, are essentially the same inside the ozone hole and in nearby areas, proving that no special uplift occurs. And it was an aberration that the average ozone concentration south of 45° South remained nearly constant for several months each in 1980, 1981, and 1982. From 1957 to 1975 ozone levels actually rose

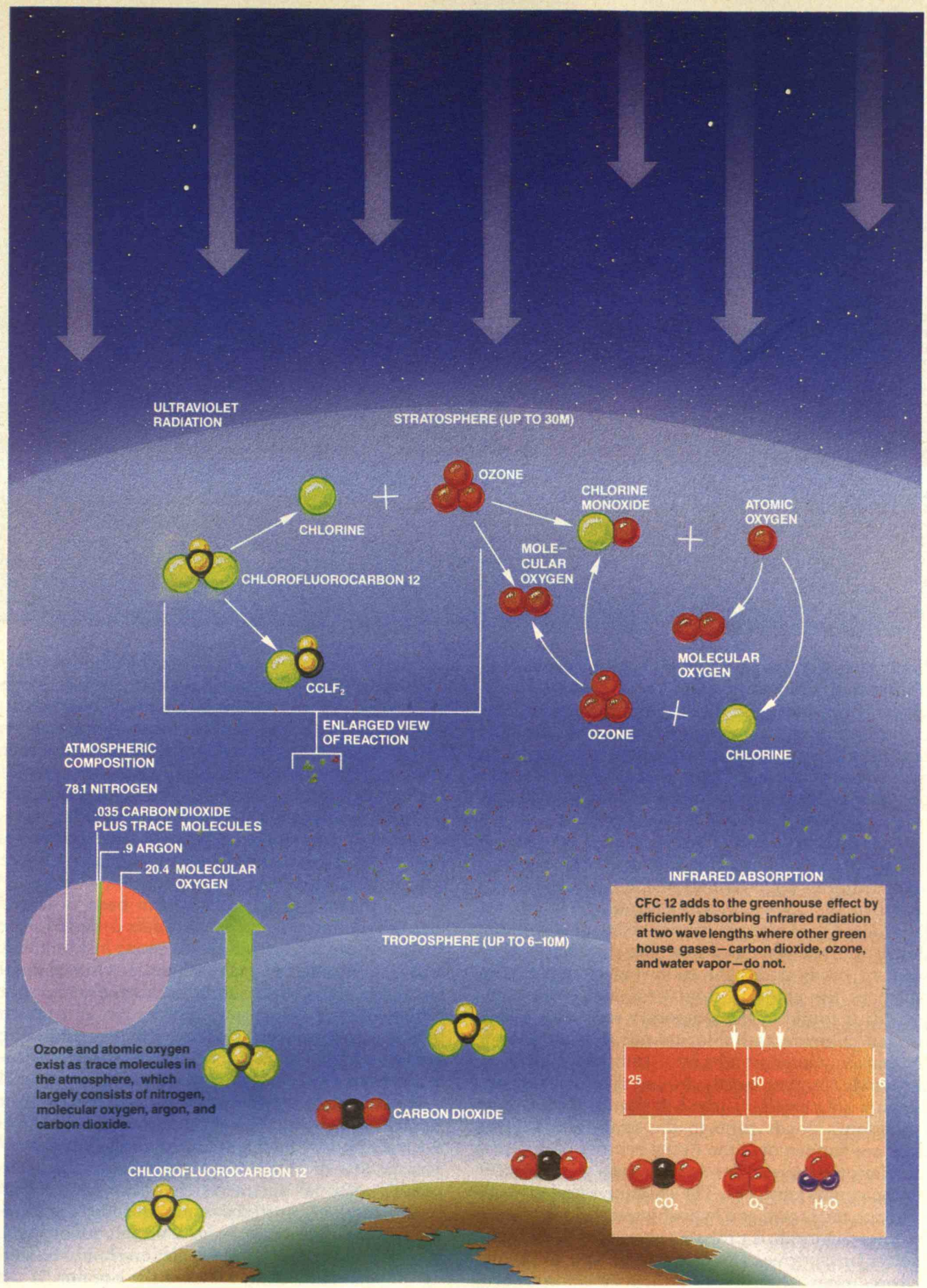
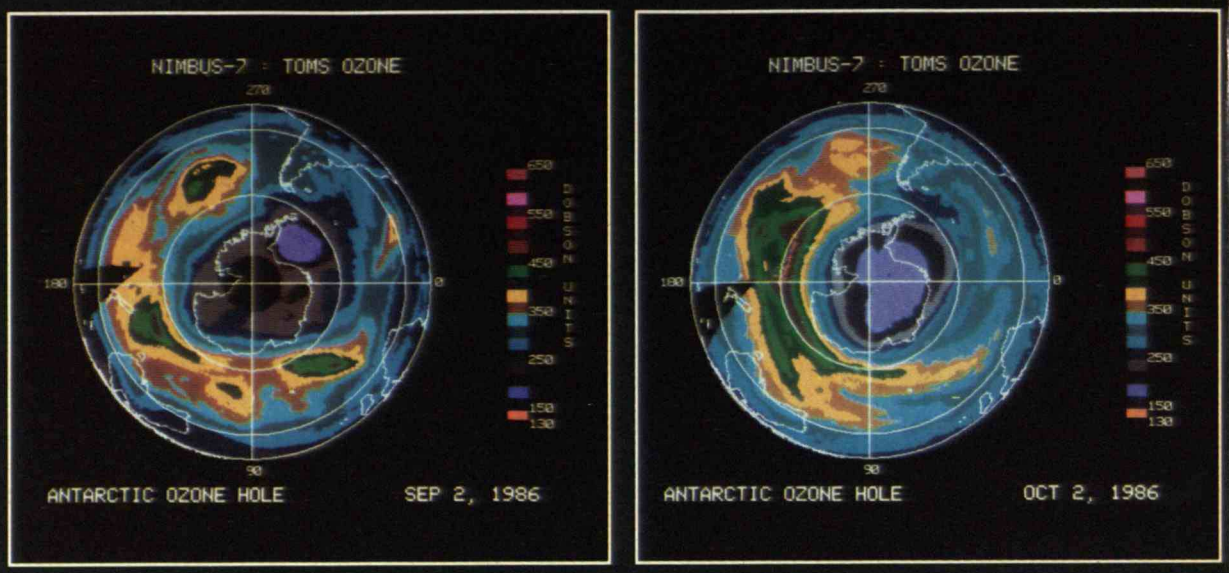


DIAGRAM: BRUCE SANDERS



Information gathered by the *Nimbus 7* satellite shows the growth of the Antarctic ozone hole during the Southern Hemisphere's spring of 1986. The least ozone is in the violet region, which last September expanded and circulated until it covered much of Antarctica. By October 2, the violet area was about the size of the U.S. One Dobson unit equals about one part per billion of ozone in the atmosphere. (On September 2 the South Pole was still in darkness, so the satellite measurements—which rely on ultraviolet radiation—could not include that area.)

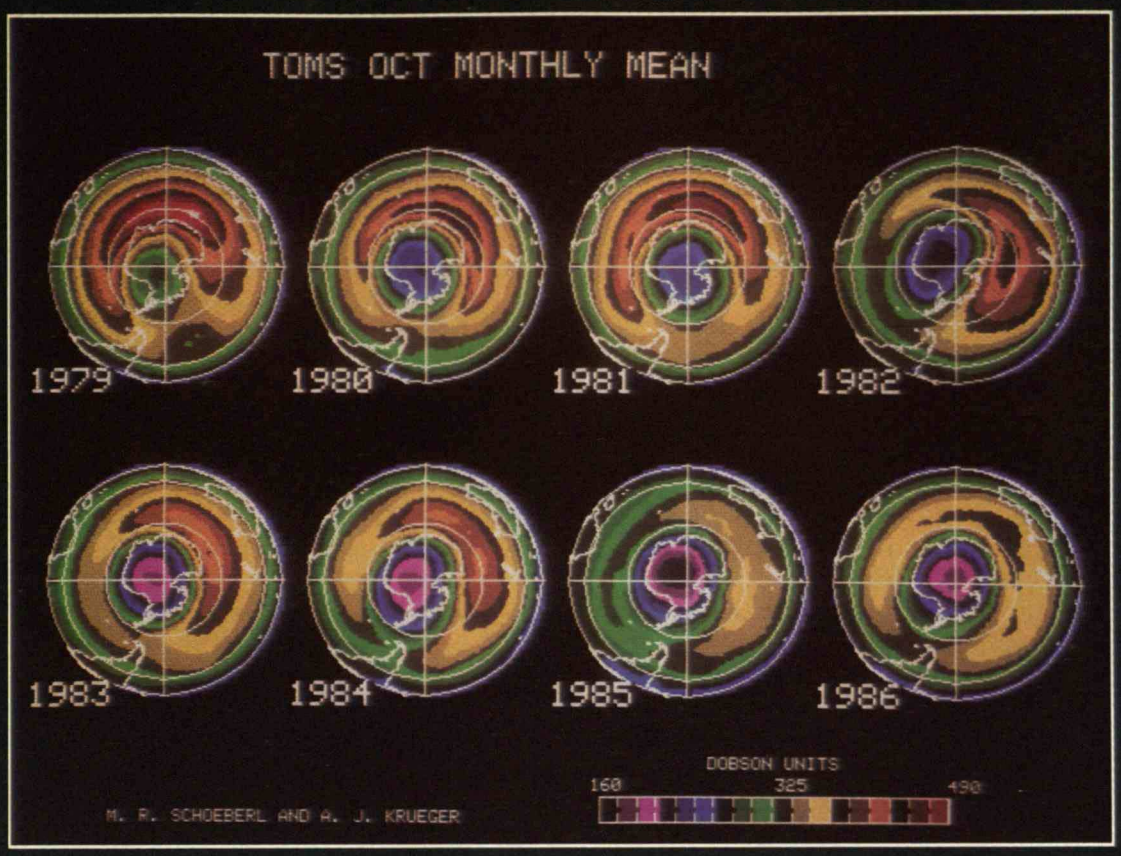
from August through October because ozone was transported southward from the Northern Hemisphere. Even more significant are the results of several experiments showing that unusual chemical reactions, many involving chlorine, are occurring over Antarctica during the period of the most rapid ozone loss. None of the purely meteorological theories explain this novel chlorine chemistry.

Only the idea that the hole is caused by chlorine chemistry has held up. The chain reaction over Antarctica differs somewhat from the ClO_x chain proposed in the 1970s, which operates in temperate latitudes. The Antarctic ozone losses are also more dramatic than what is happening elsewhere. They seem to occur under the following circumstances. Much of the chlorine from CFCs and other compounds is found in the temporary reservoirs of hydrogen chloride and chlorine nitrate year round. During the winter months over Antarctica, however, the winds circulate tightly around the polar regions, keeping air parcels in frigid darkness. Under these conditions, clouds form in the stratosphere. (This does not happen over the Arctic because of different circulation patterns.) Several reactions seem to occur on the clouds' surfaces. The chlorine nitrate is converted to nitric acid and hypochlorous acid, while the hydrogen chloride is probably converted to diatomic molecular chlorine. The first rays of light in August release atomic chlorine from the hypochlorous acid and molecular chlorine. The single chlorine atoms attack ozone and—through reactions similar to the ClO_x chain—convert ozone into molecular oxygen.

This reaction—and similar ones—continue rapidly throughout September because in the late winter and early spring the temporary reservoir molecules cannot build up. For example, nitrogen dioxide, the precursor to the chlorine-nitrate reservoir, is in extremely low concentration because it has been converted to nitric acid on the surface of the stratospheric clouds.

Such massive ozone losses have been observed only over Antarctica, but satellite data collected since 1978 indicate an average global ozone loss of about 5 percent during the past nine years. Only a small portion of this decline can be attributed to sunspot activity. Other ozone data gathered over a much longer period confirm the problem. By analyzing published data collected by ground-based instruments from 1931 to 1986, my lab has demonstrated a seasonal decrease in ozone concentrations over Arosa, Switzerland. The analysis shows as much as a 6 percent loss in the winter months and a total average loss of about 3 percent since 1970. Comparable seasonal decreases have been recorded in two other locales at the same latitude: Caribou, Maine, and Bismarck, N.D. Current atmospheric models indicate that ozone depletion should be similar at equivalent distances from the equator.

PHOTOS: NASA



The average amount of ozone over Antarctica in October has decreased since 1979, as the color code indicates.

Fortunately, substitute materials can probably be developed for almost all major uses of ozone-depleting CFCs. Some alternatives already exist, and manufacturers could replace CFCs with these in just a few months. Other substitutions could take 5 to 10 years to come into full use because factories may have to be retooled or products redesigned.

Several compounds that have much less potential for depleting stratospheric ozone could be used for cooling. Instead of CFC 12, refrigerators and automobile air conditioners could employ CFC 22, which is already used in home air conditioners. CFC 22 is largely destroyed in the lower atmosphere because it contains hydrogen, which makes it susceptible to breakdown by oxidation. Some equipment redesign is necessary before CFC 22 can be substituted for CFC 12. CFC 123, most of which also breaks down in the troposphere, is another possible substitute but it is not yet manufactured on a large scale. This is also the case with fluorocarbon 134a (FC 134a), which might be the most attractive substitute in the long term since it contains no chlorine and cannot destroy ozone. A scientific committee with broad industrial representation reported to the U.S. Senate in May that it could find no environmental or technical barriers to full-scale production of either FC 134a or CFC 123. The initial bulk cost of both compounds is estimated to be two to seven times higher than that of CFC 12, but the effect on the price of a home refrigerator—which uses less than one dollar's worth of CFC 12—would be negligible.

The United States, Canada, Sweden, and Norway banned CFC use in aerosols in the late 1970s. Manufacturers quickly switched to alternate gases such as propane and isobutane, and new delivery systems such as pump valves and roll-ons. Aerosol manufacturers in other countries could easily follow suit.

CFC substitutes can also be developed for manufacturing the plastic foam used in rigid polyurethane. Cardboard is a ready substitute for fast-food packaging, and materials such as fiberglass are available for insulation. CFC-foamed plastics are usually better insulators for a given thickness but can cost more.

Compounds such as methylene chloride and pentane are already used in manufacturing many flexible foams, and can be considered CFC replacements for automobile seats, bedding and other furniture, and some packaging. Like CFC 22, methylene chloride contains hydrogen and therefore is destroyed in the troposphere. Eventually, foam blown with hydrogen-containing CFCs might also be economically competitive.

The most significant CFC product used in the electronic solvents industry is CFC 113. Many semiconductor and other electronic components have been designed to be cleaned with this mild yet effective solvent. Other cleaning agents are often used for specific problems, but the best are much more ex-

The 1985 announcement of the Antarctic ozone hole provoked a strong cry for stricter controls on CFC use.

pensive than CFC 113. A substantial tax on CFC 113 emissions would encourage the electronics industry to recapture the compound within the plant after it is used.

International Regulation Moves Ahead

CFC use will not be effectively reduced without international regulations. Some moves toward this goal have occurred during the last few years, but not without fits and starts.

In 1976 the U.S. Environmental Protection Agency (EPA) and Food and Drug Administration (FDA) jointly announced that regulations banning CFCs in non-essential aerosol uses would take effect 18 months later. CFC use in aerosols declined precipitously, but markets for uses such as blowing foam expanded rapidly, negating much of the effect of the ban. The agencies had announced the aerosol-propellant ban as phase one, with phase two—the regulation of other CFC uses—scheduled to follow quickly. The phase-two schedule soon began to slip and was essentially discarded early in 1981. Anne Gorsuch Burford, head of the EPA between 1981 and 1983, indicated her level of concern in her memoirs published last year: "Remember a few years back when the big news was fluorocarbons that supposedly threatened the ozone layer?"

The countries with bans on aerosol propellants—the United States, Canada, Sweden, and Norway—called on all nations to follow their lead. The nations of the European Economic Community (EEC) countered that a cap on all uses of CFCs was the only effective long-term solution. While such a position has considerable merit, the EEC nations wanted to cap CFC manufacturing *capacity* at existing levels. The capacity exceeded actual EEC production levels by about 70 percent since new facilities had been built in the late 1970s. The EEC proposal would have allowed CFC production to continue expanding substantially for about another decade.

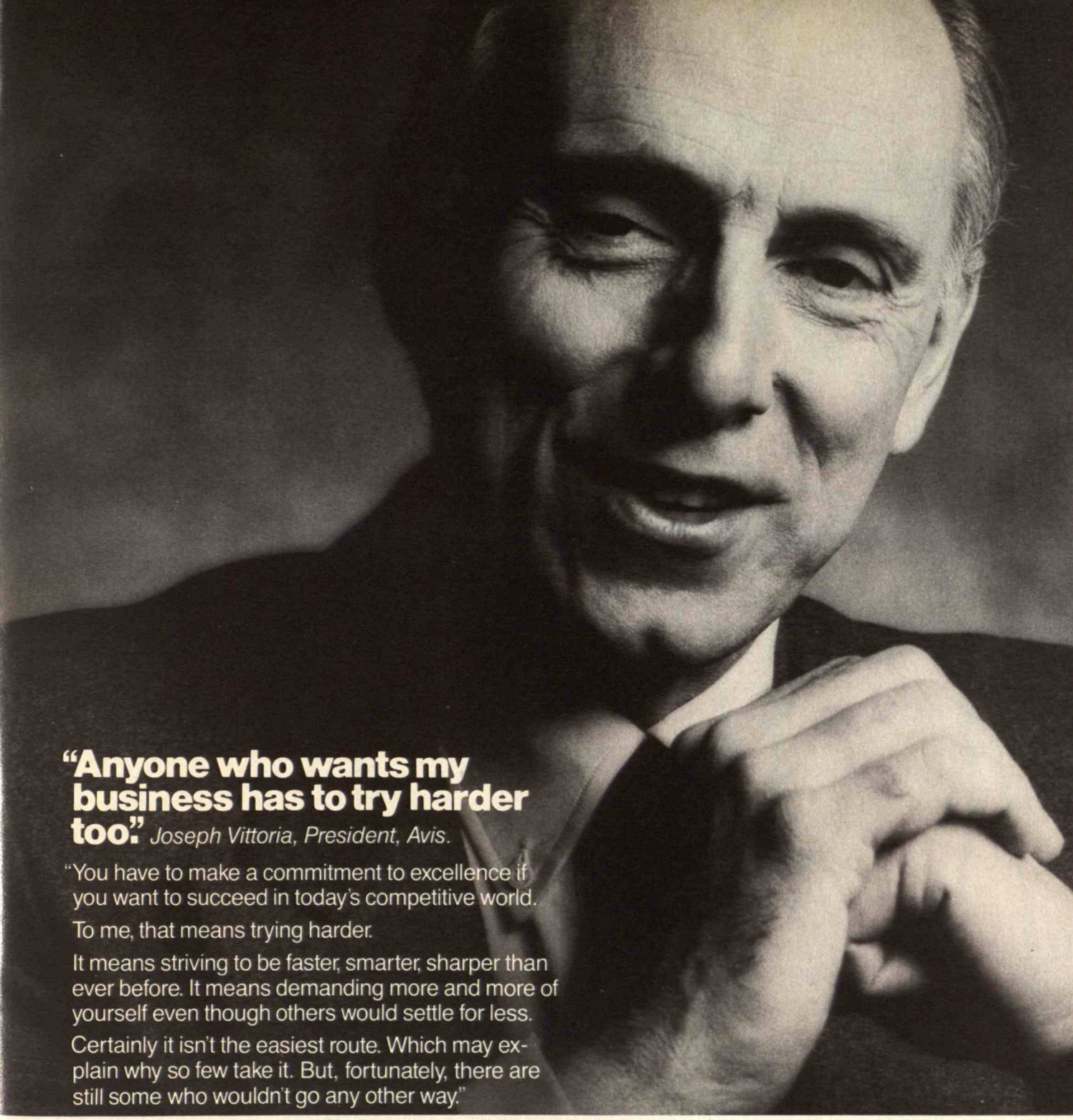
The 1985 announcement of the Antarctic ozone hole provoked a strong cry for stricter controls on CFC use. With impetus from the U.N. Environmental Programme, the Conference of Plenipotentiaries on the Protection of the Ozone Layer was convened in Vienna in March 1985. The participating countries agreed on the need "to protect human health and the environment . . . from human activities which modify or are likely to modify the ozone layer." The Conference itself offered no specific suggestions about actual protection of the ozone layer—that being left to a protocol to be negotiated later.

During 1986 and early 1987 U.S. representatives to the protocol discussions called for a cap at 1986 production levels of CFC 11, CFC 12, and CFC 113, with a 95 percent phaseout of these compounds in a decade or so. The driving forces behind this governmental position were the State Department and the EPA, the latter's interest propelled in part by a lawsuit brought by the Natural Resources Defense Council over the absence of regulatory action beyond phase one. (But statements this past May from Secretary of the Interior Donald P. Hodel suggest that not everyone in the Reagan administration even knew about the position, let alone agreed with it.)

This past March the EEC nations announced a change in policy. They were willing to agree to a production cap for CFCs 11, 12, and 113 at 1986 levels, with a 20 percent decrease to follow within a few years. In September, when representatives of 31 nations will gather in Montreal to prepare the final draft for a U.N. protocol on CFCs, the differences between the EEC and U.S. proposals are expected to be negotiated.

Another important point of contention is whether exemptions to CFC limitations should be given to developing countries such as Korea and India. Rapid growth is projected for refrigerant CFC uses in these and many other countries, and there are clear benefits to increased use of refrigeration in the Third World. But the industrialized countries fear that the Koreas of the world might gain an economic advantage in manufacturing refrigerators—and electronics and foam products—if they do not have to heed CFC limits.

Meanwhile, two industrialized nations are taking steps on their own. West Germany has recently announced independent plans to halve CFC use for aerosol propellants within 18 months. And legislation calling for a U.S. freeze of CFCs 11, 12, and 113 at 1986 production levels, with a 95 percent phaseout in as little as six years, has been introduced into both houses of Congress. The legislation would also ban imports of products that contain certain CFCs or require them in the manufacturing process. While independent actions by nations may turn out to be necessary, an immediate worldwide freeze—with a 95 percent phaseout by the early 1990s—would be preferable. □



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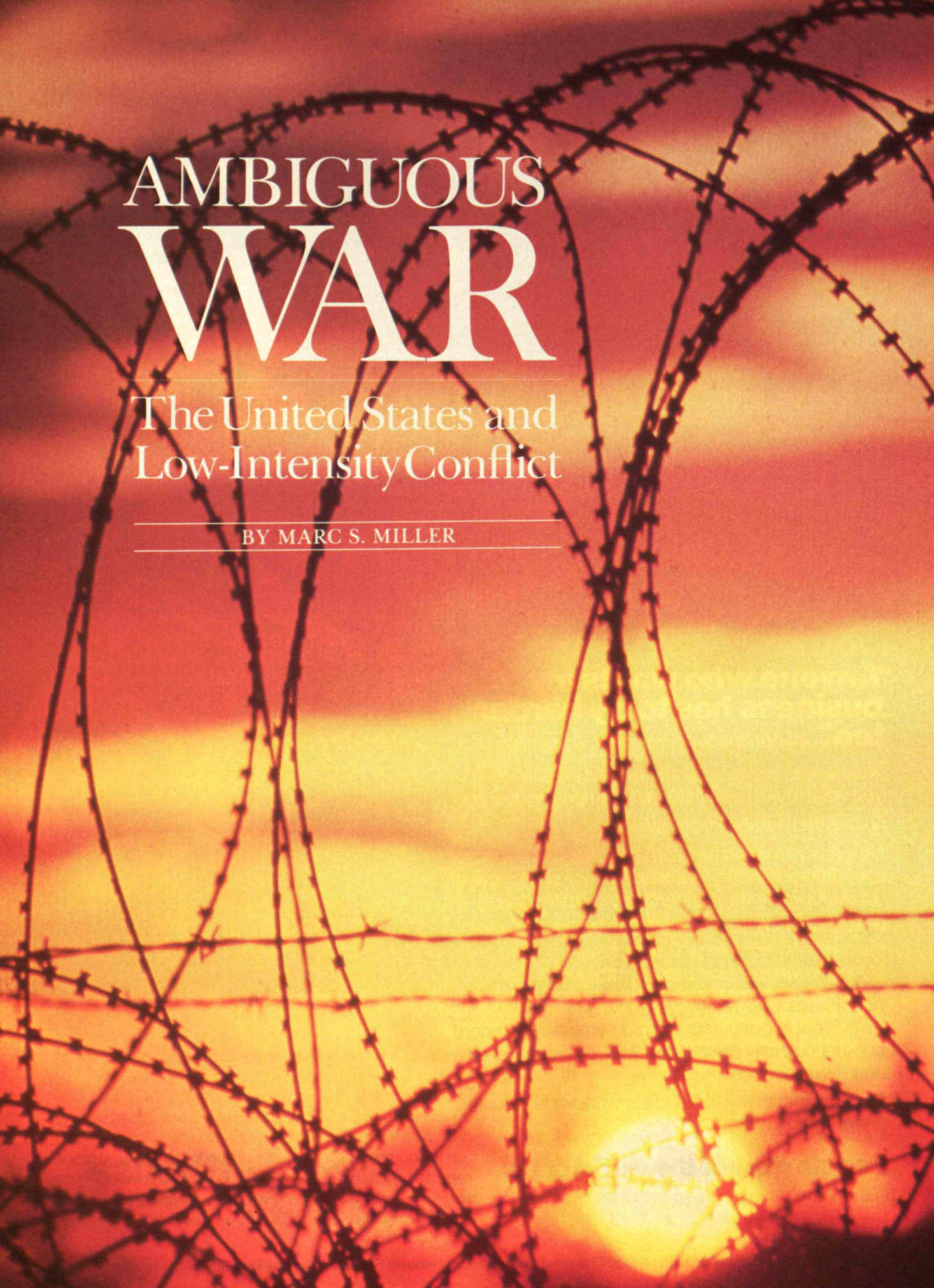
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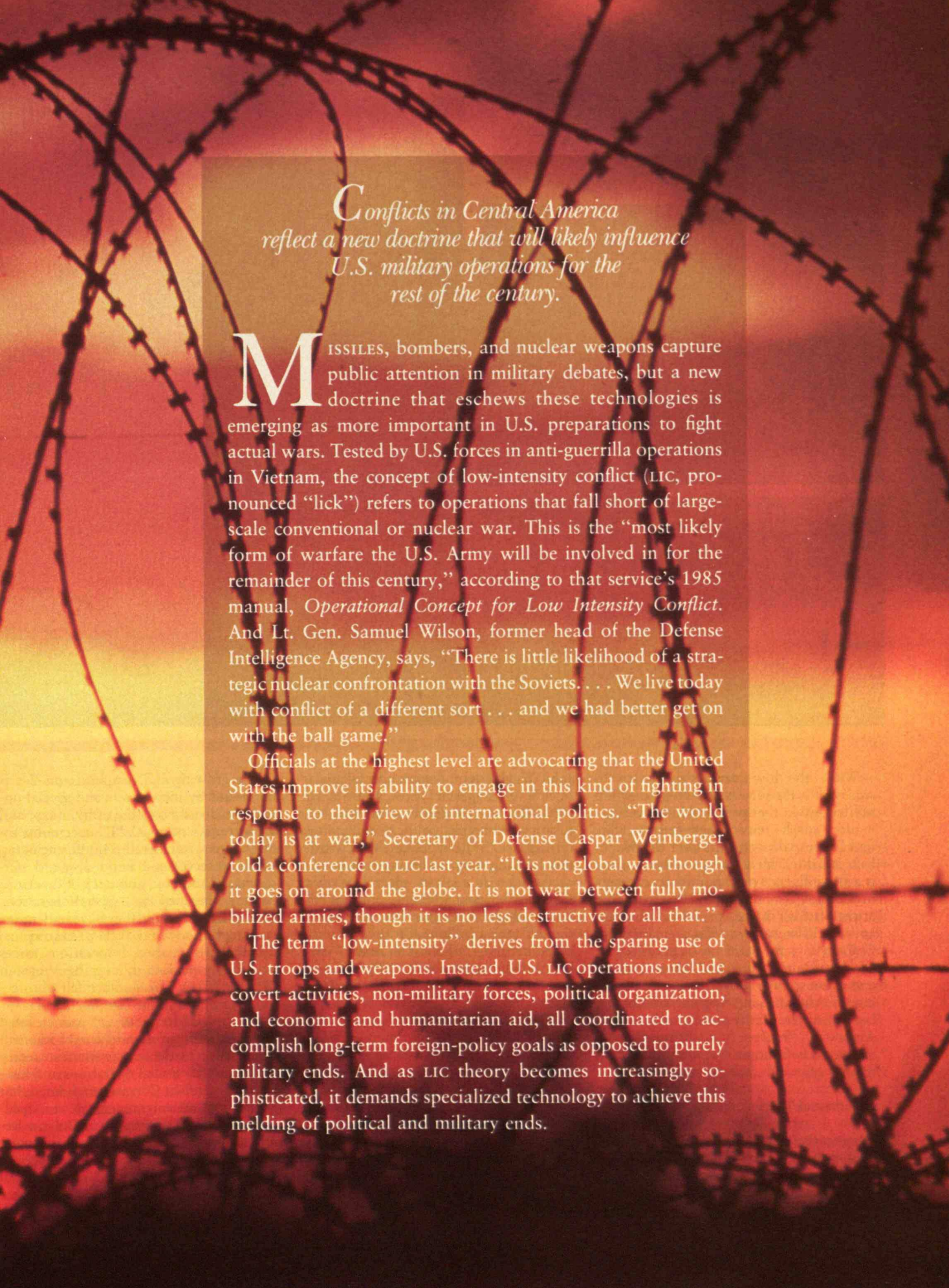
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AMBIGUOUS WAR

The United States and Low-Intensity Conflict

BY MARC S. MILLER



Conflicts in Central America reflect a new doctrine that will likely influence U.S. military operations for the rest of the century.

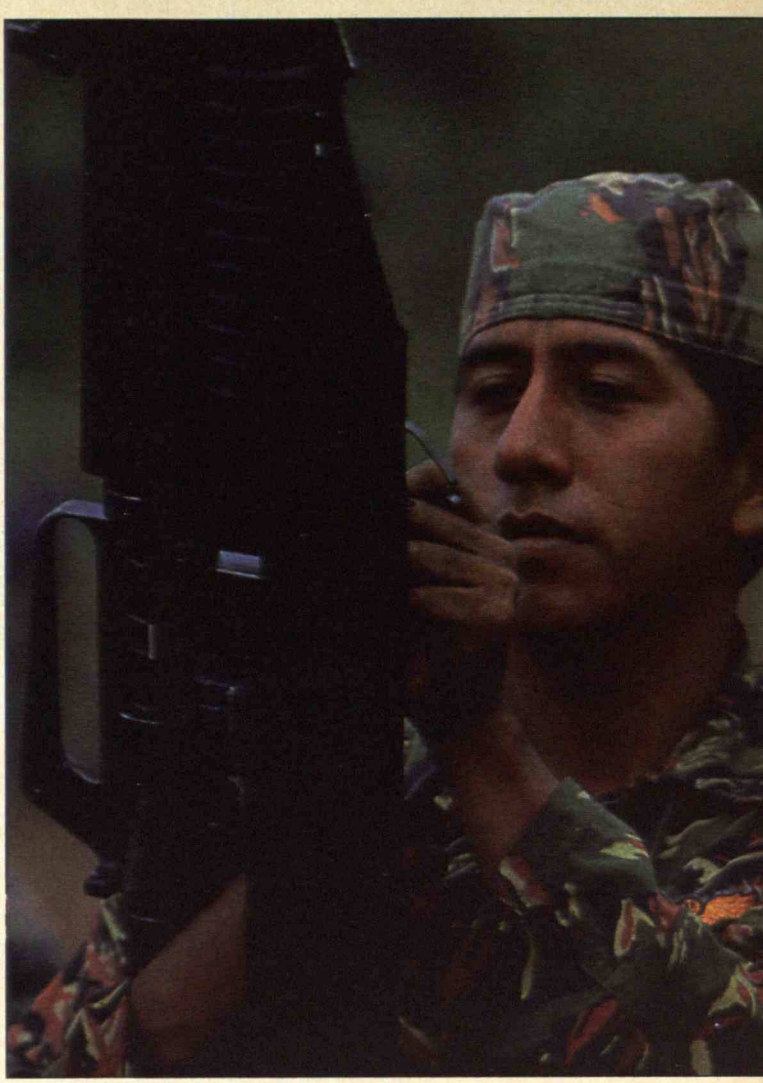
MISSILES, bombers, and nuclear weapons capture public attention in military debates, but a new doctrine that eschews these technologies is emerging as more important in U.S. preparations to fight actual wars. Tested by U.S. forces in anti-guerrilla operations in Vietnam, the concept of low-intensity conflict (LIC, pronounced "lick") refers to operations that fall short of large-scale conventional or nuclear war. This is the "most likely form of warfare the U.S. Army will be involved in for the remainder of this century," according to that service's 1985 manual, *Operational Concept for Low Intensity Conflict.* And Lt. Gen. Samuel Wilson, former head of the Defense Intelligence Agency, says, "There is little likelihood of a strategic nuclear confrontation with the Soviets. . . . We live today with conflict of a different sort . . . and we had better get on with the ball game."

Officials at the highest level are advocating that the United States improve its ability to engage in this kind of fighting in response to their view of international politics. "The world today is at war," Secretary of Defense Caspar Weinberger told a conference on LIC last year. "It is not global war, though it goes on around the globe. It is not war between fully mobilized armies, though it is no less destructive for all that."

The term "low-intensity" derives from the sparing use of U.S. troops and weapons. Instead, U.S. LIC operations include covert activities, non-military forces, political organization, and economic and humanitarian aid, all coordinated to accomplish long-term foreign-policy goals as opposed to purely military ends. And as LIC theory becomes increasingly sophisticated, it demands specialized technology to achieve this melding of political and military ends.







While the low-intensity approach to war is far from universally accepted within military and other policymaking circles—it often sparks tension between the State and Defense departments over the proper role for the armed services—the concept is a key influence on U.S. military strategy in Central America and elsewhere. LIC critic Michael Klare, professor of peace and world security studies at Hampshire College, says the doctrine, as practiced by both the United States and other countries and groups, "applies to the current fighting in Afghanistan, Angola, Cambodia, Lebanon, the Philippines, and Central America." Secretary of State George Shultz adds Ethiopia but leaves the Philippines off when making such a list.

Presidential Wars

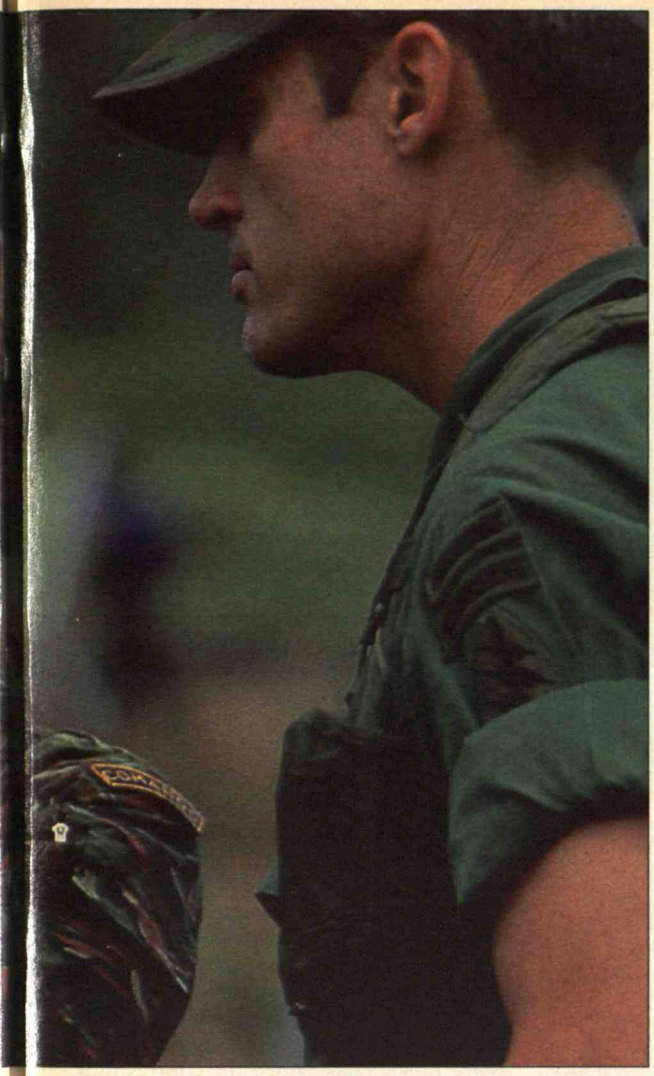
Despite the name, LIC is not truly limited—it is "low" only in that U.S. troops are not overtly committed. Rather, Col. John Waghelstein, commander of the army's Seventh Special Forces, wrote in *Military Review*, it posits total war—"a fusion of economic, political, and military intelligence." The types of conflict under this heading vary according to who you ask. Different analysts place everything from revolutions, counterrevolutions, and "internal wars" to guerrilla wars within the LIC rubric. Allan Sabrosky, professor of politics at Catholic University, terms U.S. low-intensity activities "presidential wars" because they are fought without explicit congressional approval.

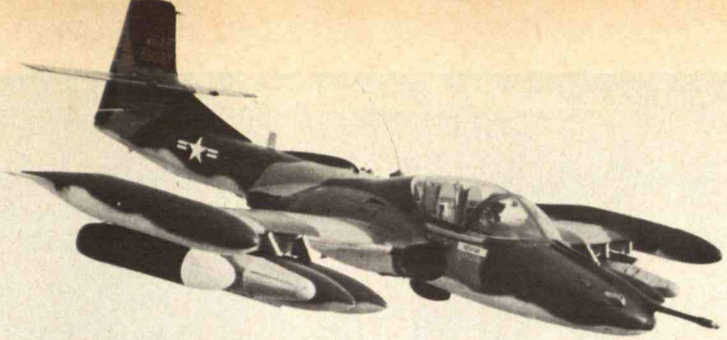
When U.S. military personnel, often called "advisors," do play an open role in LIC, the doctrine calls for "special-operations forces"—highly trained, highly mobile units such as the army's 1st Special Operations Command (SOCOM), headquartered at Fort Bragg, N.C. Such special units are trained to perform, in Secretary George Shultz's words, a "multitude of tasks," ranging from surveillance to guerrilla operations to distributing medicine for civilians. SOCOM has four departments: special forces, rangers, psychological operations, and civic affairs.

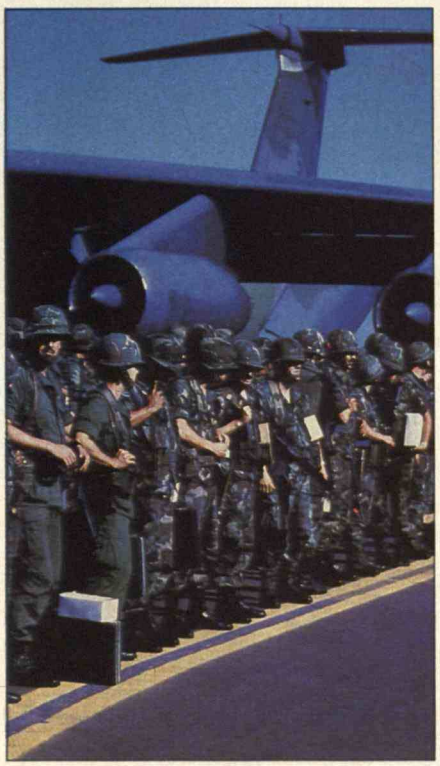
The growing U.S. emphasis on LIC is borne out by increases in the special-operations divisions of the army, navy, and air force. As of mid-1987, special-operations forces numbered 34,000, including active, reserve, and national-guard personnel. In addition, about 25,000 personnel are classified as "special-operations qualified," indicating they have undergone training but now have other assignments. By comparison, special-operations forces previously peaked during the Vietnam War at 3,700. The number fell until rebuilding began in the late 1970s.

The official status of LIC was elevated this June with the nomination of Kenneth Bergquist to be the first assistant secretary of defense for special operations and low-intensity conflict. Congress mandated that position in an amendment to the Goldwater-Nichols Department of Defense Reorganization Act of 1986. The amendment also led to the creation of an inter-service body to engage in LIC and other special operations. As the act specifies, a four-star general, James Lindsay, heads the new U.S. Special Operations Command (USSOC), activated at MacDill Air Force Base

MARC S. MILLER is a senior editor of Technology Review. *He recently was part of a Witness for Peace delegation to Nicaragua.*







The U.S. doctrine of low-intensity conflict calls for assisting other military forces rather than introducing American troops. A U.S. advisor trains a Salvadoran soldier (middle) to fight rebels.

Large-scale maneuvers train U.S. troops for direct intervention and also force adversaries to divert funds to their military budgets. Texas National Guardsmen (near left) arrive in Honduras for 1985 exercises. Marine helicopters and troops (far left) participate in a simulated invasion of Central America.

U.S. supporters of low-intensity conflict call for light, cheap, easily maintained surveillance planes for guerilla wars. Instead, the U.S. now supplies El Salvador with expensive A-37 fighter bombers (above).

in Tampa, Fla., on June 1, 1987.

U.S. military and political leaders who advocate the LIC approach to war term it a response to similar moves by America's adversaries. Weinberger has charged that the Soviet Union uses LIC as its primary method of spreading communism and subversion, and he equates Soviet LIC with terrorism: "Any effort to improve the lot of peoples is a target. . . . [I]t is not a nation's military forces that are attacked. Instead, agricultural assistance teams are murdered, as are medical assistance teams, teachers, judges, union leaders, editors, and priests." Secretary of State Shultz also invokes terrorism, calling LIC the terrorist's "answer to our conventional and nuclear strength." He labels LIC "ambiguous war" and foresees "a wide range of ambiguous threats, in the shadow area between major war and millenial peace." One purpose of the legislation creating USSOC was to augment the U.S. capability to deal with terrorism and other LIC threats.

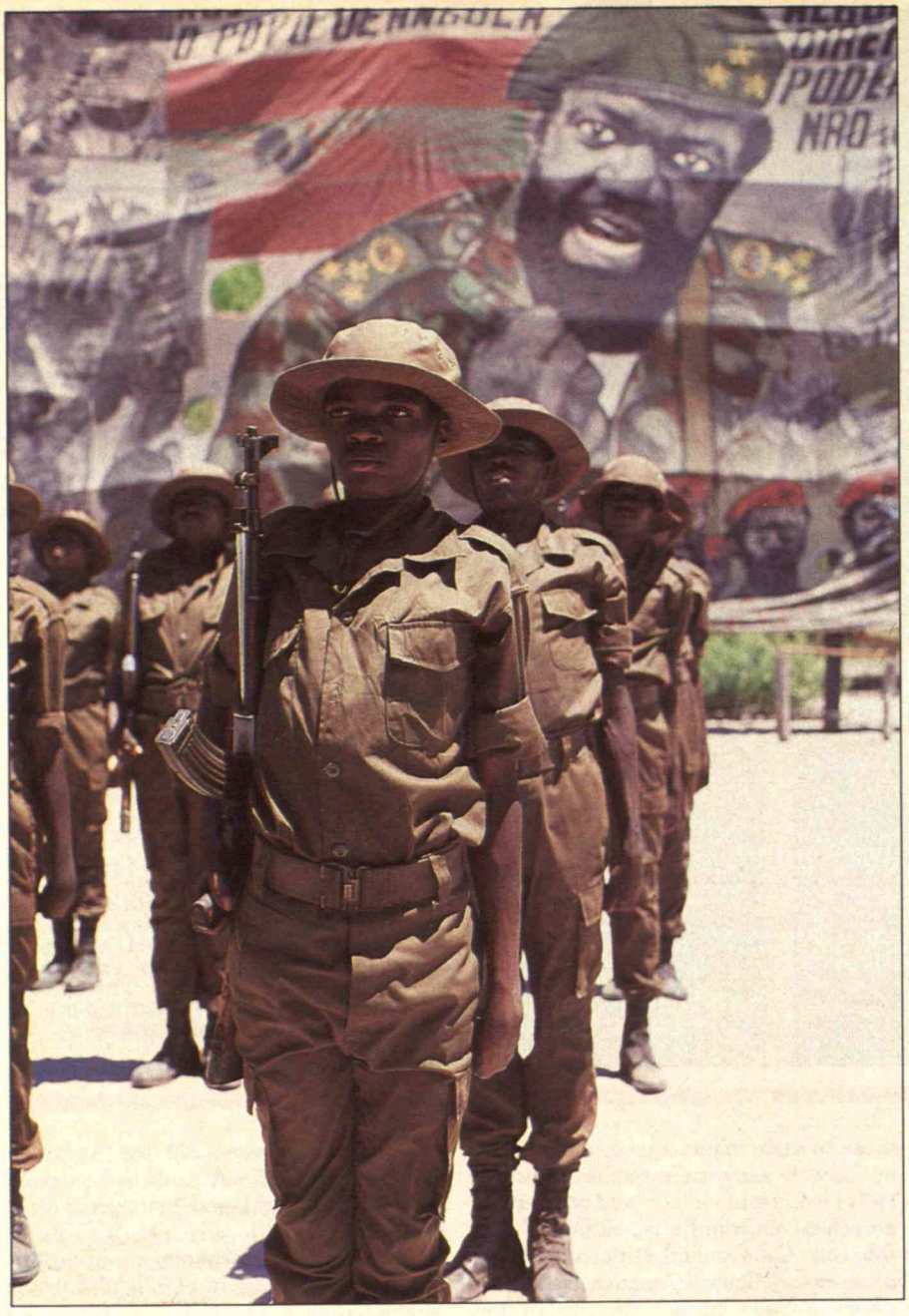
Yet both Shultz's and Weinberger's descriptions of LIC fit current U.S. offensive military involvements at least as much as those of other nations or groups. Events in Central America especially illustrate LIC's blending of military and political approaches. As Tom Barry, author of *Low Intensity Conflict* and critic of the doctrine, notes, Central America "is a laboratory for the current theories of low intensity conflict." Reacting to the public's post-Vietnam aversion to direct military intervention, U.S. policymakers have chosen instead to fund and guide the Nicaraguan contra forces, give military and civilian aid to friendly governments, and make wide use of covert operations rather than send in U.S. troops.

Appropriate Weapons

Just as it redefines the role of the military, LIC's emphasis on political ends redefines the technology for waging war. Rejecting the weaponry common in large-scale battles, LIC moves surveillance and intelligence technology to center stage instead. Sam Sarkesian, a Loyola University political scientist and leading LIC proponent, notes that some U.S. military leaders have resisted the idea of low-intensity conflict for this very reason. "In the American scheme of things, war tends to be viewed as a technological and managerial conflict," he says.

Which military technology *is* appropriate is under debate in El Salvador in the low-intensity war between U.S.-supported government troops and rebel forces. In *Armed Forces Journal International*, Tammy Arbuckle—a journalist now covering Central America who formerly accompanied CIA officers working in Laos—severely criticized U.S. military aid to El Salvador because it stresses the wrong hardware. "Helicopters, fixed-wing aircraft, and artillery are inappropriate for counterinsurgency operations," he maintains. Instead, he suggests other equipment better suited to surveillance and highly mobile guerrilla operations. "Future U.S. military material support should be limited to small arms, nothing larger than heavy machine guns and mortars, plus specialized equipment such as sniper weapons, radio communications gear, lightweight canvas boots, and other items suitable to mobile warfare in a tropical climate and difficult terrain."

PHOTOS: U.S. DEPARTMENT OF DEFENSE; CESSNA AIRCRAFT CO.





Low-intensity wars are occurring around the globe. In Angola (above), the U.S. is supporting rebels trying to overthrow the Marxist government. In the Philippines (right), the U.S. is supporting the Aquino government in its low-intensity war with the New People's Army.

An intelligence technology that could contribute to the U.S. capacity to wage low-intensity conflicts is a light, armed surveillance plane. According to Jerome Klingaman, an aerospace consultant and retired air force officer, "Many, if not all, of the friendly states in Central America, South America, and Southeast Asia would benefit considerably by the addition of a cheap, yet effective, aerial surveillance, reconnaissance, and light-strike capability."

Instead of developing such a vehicle, he says, the United States provides expensive, inappropriate A-37 fighter bombers to El Salvador under the U.S. Military Assistance Program. The A-37's ability to deliver bombs is only marginally useful against the guerrillas in El Salvador, he maintains, where distinguishing between friend and foe is difficult. "Even if light armed surveillance aircraft cost $150,000 each, that cost would be no more than the replacement cost for one A-37 engine," he points out.

In Nicaragua, the United States may be selecting technology that is more appropriate for fighting a guerrilla war. According to *New York Times* reporter James LeMoyne, "The Central Intelligence Agency has turned the contras into the best equipped guerrilla force Latin American has ever seen." During a visit to the U.S.-supplied rebels, he observed Tandy computers used to decode Sandinista radio messages as well as computerized radio coding machines and Redeye anti-aircraft missiles. Moreover, as revealed in the Iran-contra hearings, Col. Oliver North supplied approximately a dozen sophisticated KL-43 encryption machines to the contras. These highly secret devices, obtained from the National Security Agency, enable users to send and receive coded messages. According to LeMoyne, "CIA agents train and advise rebel commanders" and use their intelligence capability to provide lists of targets, including electrical towers and bridges. By focusing on such targets, the United States undermines the Nicaraguan economy as much as it weakens the Sandinista military—as called for by LIC doctrine.

LIC advocates have made a number of other suggestions for developing new technology. A report by a panel on combating terrorism, convened at Georgetown University's Center for Strategic and International Studies in 1985, called for increased R&D to develop higher-tech weapons. The panel recommended that

PHOTOS: REUTERS/BETTMANN NEWSPHOTOS

the U.S. military develop "low-profile antivehicle perimeters"—electronic fences that could surround U.S. bases and stall the engines of enemy vehicles that cross the barrier. The report also suggested that "longer-term capabilities could include remote sensing to distinguish terrorists from victims." Similarly, a 1984 conference at Maxwell Air Force Base in Alabama produced several suggestions for advanced "appropriate technologies" for LIC.

Conference participants pointed to synthetic aperture radar (SAR), a technology that the U.S. Air Force first employed in Southeast Asia, as having a potential niche in today's LIC operations. A computer in the SAR processes radar signals as a plane flies within 50 miles of its target. This technology, which provides a very high resolution image, advanced significantly with improvements in digital-processing technology in the 1970s. Because SAR works in the dark, in bad weather, and, most important, from afar, it can "image politically sensitive areas including those where overflight is not authorized or militarily advisable," according to Robert E. Lambert and Charles R. Dotson, senior program managers at Goodyear Aerospace Corp. The United States used SAR's mapping ability to plan naval mine laying in the Vietnam War, says Dotson, although he doubts it was used to aid the mining of Nicaragua's harbors in 1984.

Computer-based models and simulations for staff training and strategic analysis have recently been used in LIC special operations. In 1982 analysts at the National Defense University (NDU) at Fort McNair in Washington, D.C., developed the Strategic Unconventional Warfare Assessment Model (SUWAM)—a computer gaming model of LIC. This early model was simple and functioned only as an educational tool to make NDU students aware of LIC, but the NDU has since refined it. The result, SUWAM III, incorporates weather, terrain, equipment capabilities, and mission importance, thus approaching the complexity needed to analyze real-life situations. Sterling Hart, director of NDU's War Gaming and Simulation Center, carried SUWAM III on a Kaypro II portable computer to Hawaii and South Korea. There, according to Thomas Allen, author of *War Games*, he used it to demonstrate U.S. LIC tactics to American and Korean officials—including techniques for conducting raids and gathering intelligence in a high-risk environment.





LIC doctrine assigns an important role to civilian aid programs to augment military operations. Health care is a particular focus. Above, a U.S. flight surgeon assists a Honduran girl during military maneuvers. Unfortunately, such care is usually cosmetic, often consisting of distributing aspirin and pulling teeth. Left: During 1985 military maneuvers, engineers dig a well for residents of Choluteca, Honduras.

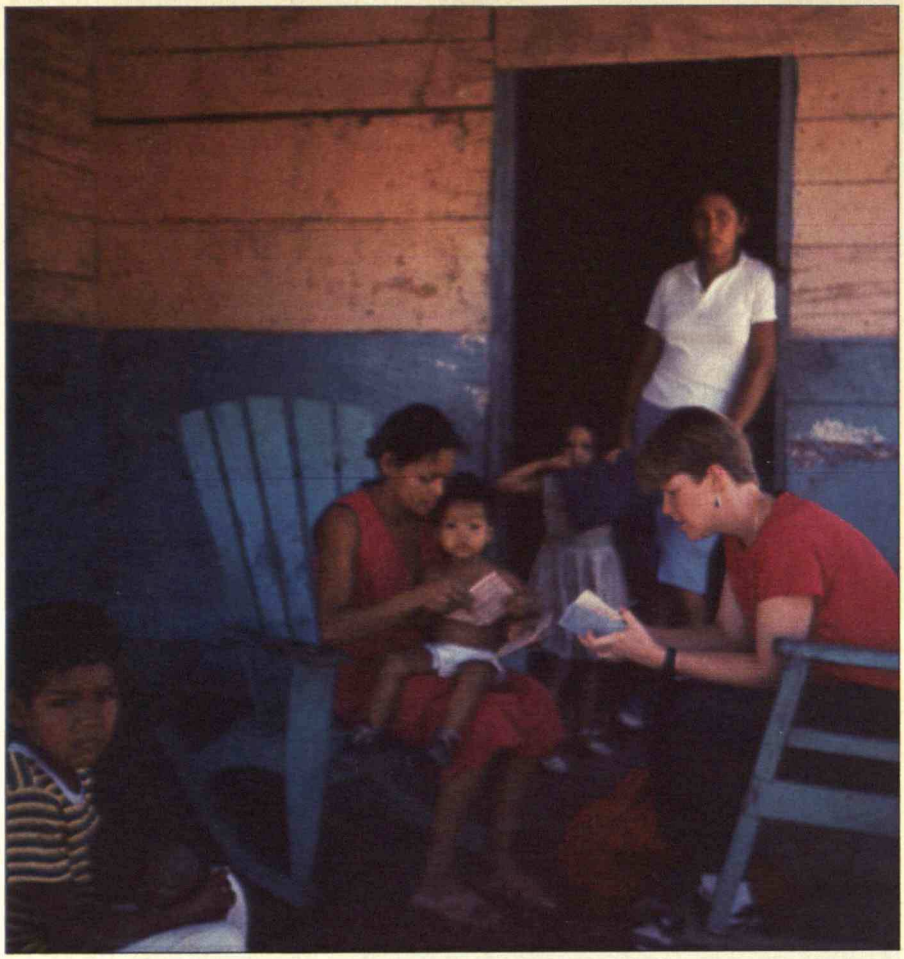
U.S. Air Force Maj. Norman Routanen advocates using electromagnetic pulses (EMP) to "disrupt or upset target [enemy] electrical systems" during LIC operations. He notes that this type of electromagnetic warfare is "quite bloodless and, therefore, quite appealing when international opinion is considered." Other applications of EMP sound like science fiction. For example, Routanen has proposed using "very powerful microwave devices to confuse, disable, or even kill the enemy." The report by the Georgetown University panel on combating terrorism similarly proposes "techniques to impair brain functions." Navy physician Capt. Paul E. Tyler sees an opposite use for electromagnetic radiation: he suggests that exposing U.S. military personnel or their allies to electromagnetic radiation might allow them to act "with minimal rest and still maintain peak performance."

Efforts to create a super soldier are not as far-fetched as they sound, nor are they new. Members of the navy's SEALS—its elite special-forces unit—took dexedrine to stay awake for several days on missions during the Vietnam War. Since at least 1954, various Defense Department agencies have conducted hundreds of experiments on ways of enabling troops to endure extremely taxing conditions. As Gen. Frank Besson, Jr., told a 1968 conference on human factors in the military, "In a limited warfare situation, man—more than ever—is *the* weapons system."

Central America: Lab for Total War

While advocating new technology, LIC proponents continually stress that the focus of LIC is not machinery—or even mil-

PHOTOS: DOD



In low-intensity conflict, the distinction between combatants and noncombatants is blurred. Above: A researcher from the Harvard School of Public Health talks with Nicaraguan civilians about the effects of the war conducted by U.S.-supported contras, which targets health clinics and farms for attack.



itary might. Richard Shultz, professor of international relations at the Fletcher School of Law and Diplomacy, warns that the special-forces division of SOCOM has mistakenly overemphasized a military approach in opposing El Salvador's rebels. He maintains that the "social, economic, and psychological aspects of counterinsurgency are being downplayed."

Instead, as LIC supporter Sam Sarkesian says, the success of LIC depends most "upon the commitment and skill of political cadre, political organization, and psychological warfare." Col. Harry Summers, Jr., a leading analyst with the Defense Department's Strategic Studies Institute, calls President Reagan's 1984 TV address on a "communist reign of terror" in Central America an example of the use of such "political and psychological instruments of power." The address served the dual purpose of trying to convince the U.S. public to support aid to the contras and threatening Nicaragua.

Military maneuvers in Central America and the Caribbean serve as even more effective psychological weapons. Sara Miles, author of *The Real War: Low Intensity Conflict in Central America,* points out that the maneuvers force Nicaragua to respond to the real possibility of an invasion and thus devote more than half of its budget to defense. This means that the government must divert limited funds from social programs, thus opening it to the charge that it spends money on weapons instead of food. After the United States conducted its Big Pine II military maneuvers in Honduras in 1983, which included 10,000 U.S. troops and a rehearsal to invade a Central American nation, Nicaragua instituted a draft. The United States responded by distributing leaflets that encouraged Nicaraguan youth to resist the draft.

The doctrine of low-intensity warfare has led to a mushrooming role for civilian and private refugee aid and development agencies—particularly in El Salvador, despite the continuing emphasis there on military solutions. As Army Lt. Col. James A. Taylor has written, "Humanitarian aid in a low-intensity conflict is as defense-oriented as the providing of training and technology. It is in no way soft." Describing LIC in general, Weinberger says, "Our Special Operations Forces play a role here as well, through Civic Action: the construction and restoration of infrastructure, the assisting of others in the improvement of their own lives, whether by restoring land, building roads, digging wells, or helping provide medical and educational services." Col. David Steele, head of U.S. MilGroup in El Salvador, puts this pragmatic approach to humanitarian aid more succinctly. "Civic action shows the people that the army doesn't just go in and rape."

Through both military and civilian aid programs, the United States supplies food, medicine, and other "humanitarian" supplies to the Salvadoran army. According to Robert Wolthius, the Defense Department's coordinator for humanitarian assistance, such aid has a crucial role in Central America. "I think we learned from Vietnam that contests like this are not only about military tactics, but about winning the hearts and minds of the people."

The United States also funds more strictly civilian projects through the Agency for International Development and other government and private agencies, including a literacy training program that consciously imitates the Sandinistas' literacy brigades. However, analyst Miles notes that the U.S.-sponsored brigades "were quietly shelved in late 1985," perhaps reflecting continuing ambivalence over this approach to war within U.S. policymaking circles.

More successful were U.S. attempts to temporarily curb the infamous abuses committed by El Salvador's security forces

PHOTOS: CINDY BROHOLM; DOD

Advocates of LIC are quietly but consistently involving the United States in permanent war.

and death squads while building up José Napoleón Duarte as a legitimate alternative to the rebels. This became especially necessary in the wake of the U.S. public outcry following the 1980 murders of Archbishop Oscar Romero and four U.S. nuns. Today human-rights violations in El Salvador may again be on the rise.

The Health Front

A key political and psychological battlefield throughout Central America is health care. As with other civic-action projects, the United States seeks both to prove that its clients can improve medical care for their citizens and to limit the enemy's ability to provide such benefits.

U.S. Medical Readiness Training Exercise (Medretes) teams have been especially active in Honduras, supplying health care to civilians during military maneuvers. According to Capt. Carol Corn, supervisor of Medretes at the Palmerola Air Base in Honduras, in 1984 medical teams treated as many as 5,000 rural people a day. However, the Medretes teams mostly distributed aspirin and pulled teeth. As Corn admitted in an interview with author Tom Barry, "It's mostly public relations."

Moreover, according to public-health specialists Steven Gloyd of the University of Washington in Seattle and Paul Epstein of Harvard, the Medretes teams were "insensitive to the particular health care needs of Hondurans. Most of the treatment they gave out was inappropriate." Among other problems, the teams handed out a drug that kills parasites that affect U.S. children but that is useless against hookworm, the primary parasite affecting Honduran children. Gloyd and Epstein estimate that as many as 30 percent of the tooth extractions were unnecessary.

U.S.-supported forces have specifically targeted the health-care system in Nicaragua—which greatly expanded services between 1980 and 1983—for attack. Says Miles, "There is a conscious effort to remove successful social programs" because of the goodwill they generate for the Nicaraguan government.

Concerned about the ramifications of this policy, Columbia University researchers Richard Garfield, Thomas Frieden, and Sten Vermund have surveyed the impacts of the war on the health of noncombatants. Writing in the *American Journal of Public Health,* they note that civilians accounted for nearly a third of all war-related deaths in Nicaragua through mid-1986, including 42 health workers killed by contras. Between 1983 and 1984 the number of medical visits declined 9 percent and hospitalizations declined 10 percent. Coverage of a supplemental feeding program for malnourished children declined from 38 percent in 1983 to 28 percent in 1985.

The researchers attribute the declines to the closing of health centers—contras have completely or partially destroyed 65 clinics—and to the mobilization of over 5,000 health-care workers into the militia for up to a year each. The researchers also found that attacks on health clinics and health-care workers have contributed to recent malaria, dengue, and measles outbreaks.

A pilot study conducted by the Nicaragua Health Study Collaborative of the Harvard School of Public Health and Nicaragua's schools of medicine and public health further documents the impact on civilians of the U.S.-directed low-intensity war. The study focused on the health of women and children, comparing factors such as nutrition and access to health services in two rural towns: Acoyapa, in the center of a war zone, and El Ostional, which has not suffered any direct attacks for three years. According to collaborative member and public-health nurse Cindy Broholm, the study shows how LIC "blurs the distinction between combatants and civilians."

The study documents the physical disruption of both communities, especially Acoyapa. While the figures are preliminary, attacks on civilian targets, say the researchers, have clear public-health implications. For example, both literacy rates for women and school attendance have declined, and it has long been recognized that a mother's educational status is connected with infant mortality. The study also found that recent contra attacks near Acoyapa have forced a fifth of the people surveyed to leave agricultural production. As food shortages increase and diets become more limited, health can be expected to decline. Moreover, the most reliable indicators available suggest that only about half as many children and women have received tetanus, polio, and DPT vaccines in the war village of Acoyapa as in El Ostional. The long-term effects of LIC may be even more severe than is now obvious, since the results of factors such as malnutrition and lower rates of vaccinations may take years to appear.

From Covert to Overt

That civilians are the victims of LIC is not surprising, since the doctrine considers them integral to the struggle to attain political goals. Says Secretary of Defense Weinberger, "The social and economic dimensions of these conflicts are of paramount importance." However, unlike aid that is labeled humanitarian, attacks on non-combatants can be counterproductive in gaining domestic and international acceptance for such operations. Therefore, one of LIC's greatest advantages and fundamental requirements—especially given widespread opposition to Reagan administration foreign-policy goals and post-Vietnam reluctance to commit U.S. troops—is its low profile and emphasis on covert operations. Secretary of State Shultz refers to "an important new role for our military in the area of covert operations," regretting the "web of restrictions on executive action embedded in our laws" that has hindered U.S. operations since Vietnam.

J. Michael Kelly, deputy assistant secretary of the air force, believes that even though LIC doctrine calls for a great deal of secrecy, in the long term it must win the support of the U.S. public. "I think the most critical special operations mission we have today is to persuade the American people that the communists are out to get us." Similarly, Col. Waghelstein proposes that troop training for counterinsurgency missions occur in public—not just on military reservations—to get "the [U.S.] populace familiar with this type of warfare."

Public acceptance is crucial, Shultz emphasizes, because LIC requires a long-term commitment: "The safeguarding of fragile democracies and vulnerable allies against subversion, in Central America or elsewhere, will require more than brief and quickly completed uses of American power." Sam Nunn (D-Ga.), chair of the Senate Armed Services Committee, agrees: "I'd rather flex our muscles a little bit on a weekly basis than have to resort to a great display of force at some very high level of danger."

Indeed, on both sides of the aisle, LIC advocates are quietly but consistently involving the United States in permanent war. The enemy is ostensibly communist subversion, but in Central America—and wherever the United States wages low-intensity conflict—the targets and the victims are ordinary people. □



Stemming the Spread of Nuclear Weapons

BY MARVIN M. MILLER

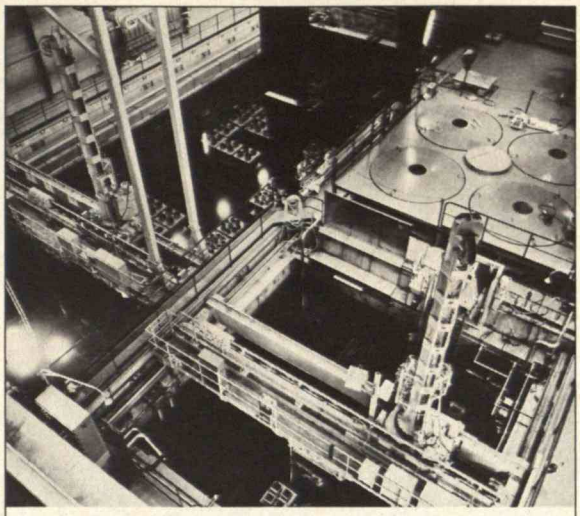
PREVENTING the spread of nuclear weapons is often considered a universal good like ending hunger or protecting the environment, but in practice there are competing concerns. The price nations are willing to pay to minimize nuclear proliferation depends on how compatible this goal is with other foreign policy objectives. For example, when England developed the bomb in 1952, U.S. opposition was muted at best, since the two nations are traditional allies. And all nations must recognize the limits of their influence. When the Soviets produced a bomb in 1949, the United States could do little to stop them.

The United States faces similar difficulties in fashioning a policy to turn back the clock on any activities related to the development of nuclear weapons in countries such as Israel, Pakistan, India, and South Africa. For instance, while the United States is concerned that Pakistan may be developing nuclear weapons, it values Pakistani support for the resistance to the Soviet-backed regime in Afghanistan. Consequently, we have been supplying Pakistan with economic and military aid, including sophisticated conventional armaments, while stating that this assistance will be terminated unless the administration can certify to Congress that the country does not possess nuclear explosives. Pakistan has been accepting the assistance and disavowing any intentions to produce such weapons, while continuing nuclear activities that the U.S. ambassador to Pakistan, Deane Hinton, recently characterized as "inconsistent with a purely peaceful program."

Both U.S. and Pakistani positions have hardened lately. There are persistent reports of Pakistani efforts to acquire weapons-related technology, and in a recent interview Abdul

We need to improve inspections of nuclear facilities and strengthen export controls. But the spread of nuclear weapons will not be stemmed unless the superpowers get serious about arms control.

ILLUSTRATION: JOHN O'SULLIVAN



This reprocessing plant near Cherbourg, France, recovers plutonium from spent reactor fuel. The plutonium is later fabricated into new fuel elements for reactors in France and other nations. Several European countries and Japan envision widespread reprocessing. Since plutonium can be used to make bombs, this could increase the spread of nuclear weapons. Nations could divert plutonium from peaceful uses, or terrorists could steal it while it is in transit.

Khan, Pakistan's best-known nuclear scientist, indicated that his country already has the capability to build bombs. The reaction in Congress has been to place more restrictions on U.S. aid, while in Pakistan a high government official warned, "No power on earth can deter Pakistan from pursuing its peaceful nuclear policy, no matter what difficulties Pakistan has to face and what sacrifices we have to undergo."

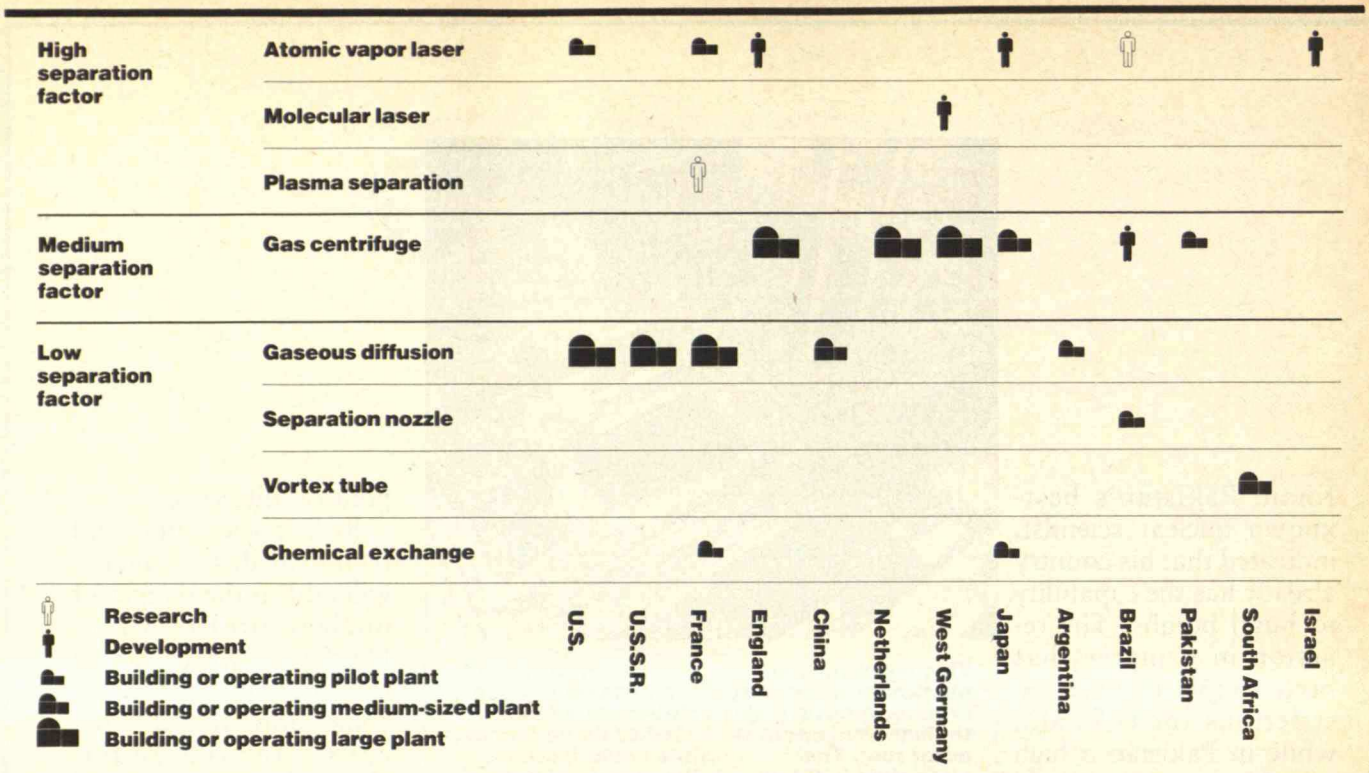
The situation is complicated by Pakistan's antagonistic relations with India, which exploded a "peaceful nuclear device" in 1974 and is considered capable of producing nuclear weapons. Pakistan has proposed that India join it in implementing measures such as allowing inspections of nuclear facilities to ensure that they are used for civilian purposes. India has refused to go along, arguing that the proposal does not address concerns about the nuclear capability of its recent adversary, China.

Other cases pose similar dilemmas. Like Pakistan, South Africa operates a uranium-enrichment plant not open to international inspection that could be used to make nuclear material for weapons. While the country might allow inspection in return for support for apartheid, that is out of the question. On the other hand, the United States does not want to pressure South Africa on the nuclear issue by imposing strong sanctions. Such actions could topple the present government and bring to power another government that would not be as favorable to our geopolitical interests.

Recent economic and technical developments will add to the danger of nuclear proliferation. Plutonium, which can be used in weapons, may become more available because Japan, India, Argentina, and several Western European countries are planning to employ it in reactors. New processes may simplify the task of producing highly enriched uranium (HEU), which can also be used for bombs. And the march of technology in areas from computers to conventional explosives has simplified the task of reinventing the bomb. The consensus among weapons experts is that even without full-scale nuclear testing, nations could develop reliable fission explosives of the type dropped on Nagasaki. Given weapons-grade material, terrorists could build crude weapons, too.

The result could be a world with five to ten de facto nuclear-weapons states—countries that could produce weapons materials and use them in untested but reliable designs—as well as an increased risk of nuclear terrorism. This does not exactly constitute a "nuclear-armed crowd"—a phrase coined by University of Chicago political scientist Albert Wohlstetter to characterize a situation in which many states have stockpiled nuclear weapons. Still, the prospect is sobering. A conflict in a volatile region such as South Asia or the Middle East might escalate to the point where nuclear weapons are used by the adversaries themselves, allies acting on their behalf, or terrorist groups.

PHOTOGRAPH: FRENCH EMBASSY PRESS



What might be done? Two mechanisms need to be strengthened: international safeguards to ensure that civilian nuclear materials and technology are not diverted to military purposes, and controls on the export of such materials and technology. Plutonium should be used in nuclear reactors only if protection can be assured against theft or diversion to military uses. Also, more states should be encouraged to sign the 1970 Non-Proliferation Treaty (NPT), which embodies an international consensus against proliferation. It has already been signed by 135 nations, including the United States and the Soviet Union.

In the long run the nuclear-weapons states, particularly the superpowers, must reduce the military and symbolic value attached to these armaments. An important step would be a comprehensive ban on testing nuclear weapons. Measures like this would create an international climate more favorable to strengthening safeguards and export controls, and would encourage wider adherence to the NPT.

Nuclear Safeguards

The International Atomic Energy Agency (IAEA), located in Vienna, administers a system of safeguards to verify that nations do not turn civilian nuclear material and technology to military purposes. The system is based on inspections, which are applied in two circumstances. First, non-weapons states that have signed the NPT are required to accept safeguards on all their nuclear material and technology. Second, suppliers of nuclear materials and equipment usually require safeguards even if the recipients are not party to the treaty.

However, nuclear material and technology that non-NPT states have produced indigenously are usually not safeguarded. Thus while 96 countries have agreed to safeguards covering more than 95 percent of the nuclear facilities outside the 5 declared nuclear-weapons states, 14 facilities are known to be operating without safeguards in 5 nations that have not signed the NPT: Argentina, India, Israel, Pakistan, and South Africa.

This lack of complete coverage is the most significant limitation of IAEA safeguards. They can be of no help where they are not applied.

To be credible when they are applied, safeguards must be able to detect a violation of a state's pledge of peaceful use. According to guidelines governing the safeguards system in NPT states, the technical objective is "timely detection" in the event that "significant quantities" of nuclear material are diverted to manufacture nuclear weapons or explosives, or to accomplish unknown purposes. The "risk" of prompt detection is supposed to deter a nation from attempting to divert material.

The IAEA has defined a "significant quantity" of nuclear material as the approximate amount needed to make an explosive—8 kilograms of plutonium or 25 kilograms of U-235 in highly enriched form (HEU). Detection is "timely" if it occurs within the amount

Marvin M. Miller is a senior research scientist with the Department of Nuclear Engineering and the Center for International Studies at M.I.T. He has long been interested in the problems of nuclear-weapons proliferation and the environmental impacts of energy use.

DIAGRAM: TOM BRIGGS DESIGN



Far left: Uranium is enriched to increase the concentration of U-235, the isotope that best sustains fission. The "stage separation factor" measures how much enrichment takes place at each step of the process. The higher this factor, the fewer steps are necessary. Gaseous diffusion entails thousands of steps to enrich natural uranium for use in a typical power reactor. The gas centrifuge requires tens of steps, and the atomic vapor laser process requires only one. Left: The British Nuclear Fuels uranium-enrichment complex near Chester, England. The buildings in the front house gas centrifuges. In back is a decommissioned gaseous-diffusion plant.

of time necessary to make a bomb from the material—one to three weeks for pure plutonium or HEU and one to three months for spent reactor fuel. (Plutonium would have to be separated from uranium and radioactive fission products in such fuel to make a bomb.) A 95 percent probability of being detected is considered sufficient "risk" to deter a nation from trying to divert significant quantities of material from a nuclear facility.

The primary means of detecting diversion is simple in principle. The process is technically known as "material accountancy." Each facility operator reports the initial inventory of nuclear material, as well as subsequent inputs and outputs. Inspectors attempt to verify these figures by means such as checking the operator's records for consistency and making their own measurements. Adding the inputs and subtracting the outputs gives the amount that ought to be in the ending inventory. Any "material unaccounted for" could be considered diverted.

Unfortunately, measurement error often makes it difficult to attribute the apparent existence of such material to diversion. This problem is particularly acute in facilities that process nuclear material in bulk rather than in discrete units such as fuel assemblies for nuclear reactors. The most sensitive bulk facilities are reprocessing plants, which separate plutonium from spent reactor fuel, and fuel-fabrication plants, where the separated plutonium is made into fuel assemblies.

Given current technology, the amount of plutonium that passes through a reprocessing plant can be measured to an accuracy of about 1 percent. For a large plant that processes 1,000 metric tons of reactor fuel annually, the result is an uncertainty of about 150 kilograms of plutonium per year, disregarding the error in measuring the inventory, which is usually smaller. According to IAEA criteria, this is enough for some 20 bombs. If measurements were made every two weeks, the amount of material processed would be smaller, and the IAEA could theoretically detect the diversion of plutonium before a bomb could be made. However, such frequent measurements are not feasible. Taking an accurate inventory in a reprocessing plant requires shutting it down, and doing this more than once or twice a year would unacceptably disrupt operation.

Alternative procedures may be possible. By sampling the materials being processed and reading the operator's instruments, inspectors might be able to take accurate enough inventories while a plant is functioning. However, the operator may not agree to the use of such techniques because they could interfere with running the plant or pose a risk of disclosing proprietary information. Furthermore, safeguards must be applied in a way that minimizes the intrusiveness of verifying a sovereign state's trustworthiness. In practice, this means that inspectors cannot roam around a plant like Sherlock Holmes looking for evidence of foul play. In general, they must give operators advance notice to enter a plant, check records, and make measurements.

Such constraints obviously limit the ability of the IAEA to detect diversion. It may never be possible for the safeguards system to be infallible in ascertaining whether the operator of a nuclear facility, in

PHOTOGRAPH: BRITISH NUCLEAR FUELS LTD.

EXPORT CAPABILITIES OF MERGING SUPPLIER COUNTRIES

Country	Power reactors	Major power reactor components	Research reactors and components	Sensitive nuclear technology†	Basic technical training and advice
Argentina	• (future)	•	•	•	•
Brazil		•	•	• (future)	•
China	• (future)	•	•	•	•
India	•	•	•	•	•
Israel			•	•	•
Pakistan			• (future)	•	•
South Africa			•	•	•
South Korea*	• (future)	•	•	•	•
Taiwan*			•		•

†Includes uranium enrichment, reprocessing, and/or heavy water production.

*NPT parties

particular a large reprocessing plant, has diverted enough nuclear material to make a bomb.

Does that matter? Safeguard analysts such as James De Montmollin of the Sandia National Laboratory do not believe so. Nations that sign the NPT and voluntarily accept international inspections will presumably not divert material for a bomb. Thus, the effectiveness of NPT safeguards should not be judged solely on whether specific inspection goals are always met. Finally, no large plutonium bulk facilities are now operating in non-weapons states.

While this argument has merit, not all NPT states have impeccable non-proliferation credentials. Libya, which reportedly attempted to purchase nuclear weapons from China during the 1970s, is an obvious example. Moreover, non-NPT states that accept safeguards only because a supplier requires them to cannot be given the same credence as nations that have signed the treaty. Nor do they tend to cooperate as fully with the IAEA, and this can make even small plants difficult to safeguard. The possible existence in non-NPT states of unsafeguarded "sources" where nuclear materials are manufactured and "sinks" where such materials reside also makes it harder to ensure that safeguarded facilities are not being used to make weapons materials. It might seem appropriate to apply the strictest safeguards where the proliferation threat is greatest, but the IAEA cannot discriminate in this way.

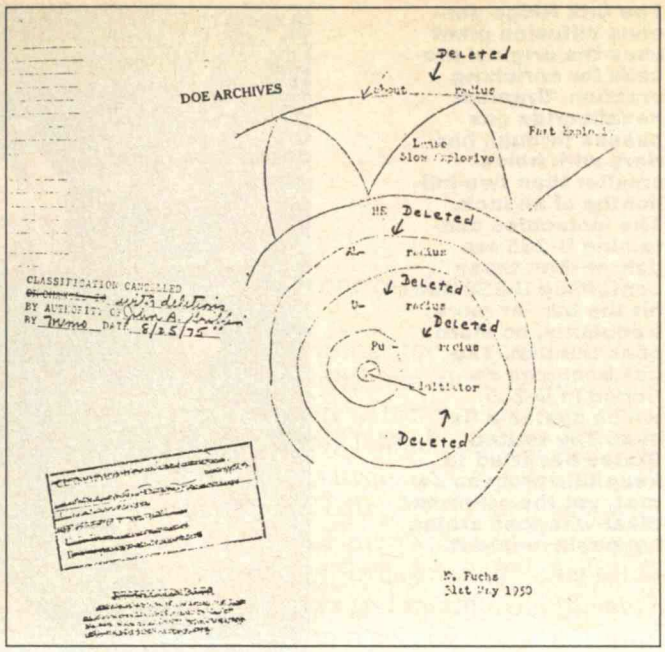
Many of the constraints on the safeguards system stem from the fact that the IAEA is not an international police agency with broad authority to search for missing materials and prevent, rather then just detect, diversion. In a world of sovereign states, it would be unrealistic to expect any international organization to be granted such powers.

Nevertheless, safeguards play an indispensable role in assuring that nations abide by their peaceful undertakings, and they can be made more effective even within their constraints. The safeguards budget, which is provided largely by the major nuclear nations, was approximately $30 million in 1986 and allowed for about 2000 inspections by 190 inspectors at 500 nuclear facilities worldwide. This budget will need to be increased to pay for more inspectors as additional nuclear facilities open, and to handle any significant increase in the use of plutonium. (Safeguards will be applied at 60 nuclear-power reactors now under construction in non-weapons states.) The professional level of inspectors and staff should be improved, and nations must be encouraged to cooperate more fully with the IAEA in implementing new safeguards techniques. However, the greatest limitation of safeguards is that they are not universally applied.

Export Controls

Since the beginning of the nuclear age, countries such as the United States that have possessed nuclear technology and materials have exported them only on certain conditions, such as a pledge of peaceful use. However, at first there was little uniformity in different nuclear suppliers' requirements for export. When the NPT went into effect in 1970, a group of suppliers including the United States, the Soviet Union, England, West Germany, and Switzerland met to consider how to consistently implement the provision requiring safeguards on exports of nuclear materials and equipment. In 1971 they agreed on

DIAGRAM: TOM BRIGGS DESIGN



In 1945 Klaus Fuchs, a British physicist working on the Manhattan Project, gave a Soviet agent a detailed description of the type of fission bomb dropped on Nagasaki. After Fuchs's arrest in 1950 he drew this diagram to show what he had given the Soviets. Dimensions are deleted, as they remain classified. An increasing number of de facto nuclear states could build this type of bomb.

guidelines governing nuclear trade and established a list of materials and equipment "specially designed and prepared" for the production of plutonium and enriched uranium—for example, nuclear reactors, uranium enrichment facilities, and reprocessing plants. The group decided that export of such items should trigger safeguards.

Though an important achievement, the agreement left significant loopholes. For example, the list did not include equipment such as plant instrumentation that may be critical for the operation of a nuclear facility even though it is not "specially designed and prepared" for this purpose. The guidelines did not require safeguards on copies of exported equipment. Nor did they restrict recipients from re-exporting that equipment. And they imposed no special restrictions beyond safeguards on the export of reprocessing or uranium enrichment plants, which produce materials that could be used in weapons.

The suppliers, with the important addition of France, met again in 1975, and by 1978 they had agreed on the Nuclear Suppliers' Guidelines, which largely plug these loopholes. Nevertheless, problems remain. Most significantly, countries that want nuclear materials and technology without safeguards are often willing to pay a high price, and since there are now multiple suppliers, including private companies, for much nuclear hardware, a potential proliferator can often find one who is willing to make a deal. For example, Swiss and West German companies are currently under investigation for illegally supplying components for the uranium enrichment plant in Pakistan.

Moreover, there are practical problems in applying trigger lists to items like computers, lasers, and chemical equipment that have both nuclear and nonnuclear applications. Technology can also be transferred via documents such as blueprints, and "nuclear mercenaries" can supply valuable know-how. Controlling these channels is a formidable task, which the guidelines do not even address.

Finally, nuclear export controls need to be enlarged to embrace emerging suppliers such as India, Pakistan, Argentina, and South Africa. Many of these countries have or are acquiring experience in weapons-related technologies including reprocessing and uranium enrichment. Even if the new suppliers require recipients to accept safeguards, exporting these technologies increases the threat of proliferation.

Recycling Plutonium

It has long been recognized that if uranium continues to be used as inefficiently as it is in current facilities such as the light-water reactor, there is too little of the material in the ground to make nuclear power a long-term energy source. The nuclear establishments in the industrialized countries have always envisioned reprocessing spent fuel to extract plutonium, which could be used as fresh fuel in breeder reactors. Such reactors provide more plutonium than they consume. Since they require only about one-hundredth as much uranium as light-water reactors, they could make nuclear power a long-term energy source.

Unfortunately, this technology also increases the risk of nuclear proliferation and terrorism. Spent fuel is too radioactive to handle directly and cannot be used in a bomb, but extracted plutonium is relatively easy to handle and can be so used. And as noted, safeguards may not always be able to detect diversion of plutonium from either reprocessing plants or plants where fuel assemblies are fabricated. To minimize the risk of theft, stringent security is required at these plants, at reactors, and while the plutonium is in transit between facilities.

Over the past decade, momentum toward the breeder has been slowed by reduced demand for energy, opposition to nuclear power, concern about nuclear proliferation and terrorism, and the continued availability of low-cost uranium in countries such as Canada, Australia, and South Africa. Nevertheless, a large reprocessing plant is already operating in France, and others are under construction in England, West Germany, and Japan. As a result, several countries have made plans to substitute plutonium for some of the uranium now used in light-

DIAGRAM: U.S. DEPARTMENT OF ENERGY



The Oak Ridge gaseous diffusion plant uses the original process for enriching uranium. Uranium hexafluoride gas passes through barriers with holes smaller than two-millionths of an inch. The molecules containing U-235 are lighter than those containing U-238 and hit the barrier more frequently, so more pass through. The gas becomes enriched in U-235, which sustains fission. The United States has tried to keep this process secret, yet the other nuclear-weapons states have reinvented it.

tonium for some of the uranium now used in light- for the breeder by legitimizing plutonium use. Industry estimates are that by the year 2000 about 50 light-water reactors in Western Europe and Japan will be using some 20 metric tons of plutonium annually. Another 5 to 10 tons might be used in prototype breeders in France, England, Italy, and Japan.

The Carter administration argued that using plutonium in light-water reactors would be uneconomic, do little to provide energy security, and significantly increase the risks of nuclear proliferation and terrorism. However, the Europeans and Japanese believe that costs will decrease, that the risk of proliferation is minimal in their own countries, and that tight security can minimize the threat of terrorism. The Reagan administration has moved closer to the European and Japanese view. It is prepared to grant long-term approval for reprocessing U.S.-supplied fuel and using the extracted plutonium in "safe" countries, given adequate safeguards and security. The administration has negotiated such an agreement with Japan but has not yet submitted it to Congress for approval.

An arrangement like this one poses tough questions. Reprocessing agreements with "safe" countries could make it harder to prevent other countries from using plutonium. Moreover, solid non-proliferation credentials offer no protection from the threat of terrorism, which is a fact of life in Western Europe. Yet the proposed Japanese agreement has advantages. The risk of diversion in Japan is minimal, and the agreement allows the United States to press for the best possible safeguards and security measures. This could set a standard for plutonium use even when no U.S. permission is required.

Many countries still feel it is important to preserve the option of using nuclear power as a long-term energy source. Some day it may be possible to do this without incurring most of the risks associated with plutonium. Reactors might be developed that recycle plutonium on the site, or the enormous uranium resources in seawater could be tapped, dispensing with the need for plutonium altogether. But in the near term, several advanced nuclear countries plan to use plutonium in light-water and breeder reactors. The United States has a legitimate interest in minimizing the associated risks, and when U.S.-supplied uranium or reactors are involved, we have a legal obligation to do so under the Nuclear Non-Proliferation Act of 1978. Heavy traffic in pure plutonium should be discouraged, and it should be protected like the bomb material that it is.

The Uranium Threat

Bombs can also be made from HEU, which is produced by concentrating the U-235 isotope. Concern has generally focused on plutonium because chemically separating it from spent fuel in a reprocessing plant has been considered easier.

This was undoubtedly true in the beginning of the nuclear age when the United States developed the gaseous diffusion process for uranium enrichment. The process exploits the fact that when uranium is in gaseous form, molecules containing the U-235 isotope move on average slightly faster than those containing the more common U-238 isotope. When the gas is forced through a porous barrier, the U-235

PHOTOGRAPH: U.S. DEPARTMENT OF ENERGY

Plutonium should be protected like the bomb material that it is.

molecules strike the holes in it more frequently, and more pass through. Reinventing this process has been considered difficult and costly because of the secrecy surrounding key elements, particularly the diffusion barrier, and the large size of the equipment required. Nevertheless, all the other nuclear-weapons states have built gaseous-diffusion plants, and a pilot-scale facility is now under construction in Argentina.

The market for low-enriched uranium (LEU) for commercial reactors, which has too low a U-235 content to be useful in weapons, spurred the search for less costly alternatives to gaseous diffusion. A variety of other methods has been developed. Unfortunately, some of these could provide easier routes to making HEU for weapons.

One possibility is the high-speed gas centrifuge, which uses centrifugal force to separate U-235 from the heavier isotope U-238. Any country with a moderate industrial base can build centrifuges, and the same kind that make LEU can also make HEU.

Several other uranium enrichment techniques that have not yet been commercialized might increase the risk of proliferation in the long run. One is the sophisticated atomic vapor laser process, which uses lasers precisely tuned to given frequencies to ionize U-235 atoms—but not U-238 atoms—in a gas stream. The ionized particles can then be separated using electromagnetic fields. Two relatively low-tech chemical enrichment methods, which exploit the slight preferences of U-235 and U-238 to combine in different chemical compounds, also have good economic potential yet may increase the risk of access to HEU.

Both the chemical enrichment and the atomic laser processes are being developed to produce LEU, and it is not clear how easily they can be modified to produce HEU. A proliferator may prefer to use proven technologies such as centrifuges or gaseous diffusion. Nevertheless, these newer processes could eventually add to the risk of proliferation. Technologies that are state-of-the-art today may become commonplace tomorrow. Setting up low-tech versions of enrichment processes and solving the problem of going to HEU may be costly, but cost is rarely a proliferator's main concern. Countries developing new uranium enrichment methods should restrict their spread by enforcing classification and export policies, and there should be IAEA safeguards on any commercial plants that are built.

Safeguards and Export Controls Are Not Enough

Checking proliferation using the traditional approaches alone could be problematical. While safeguards can be made more effective, there is little prospect that the major NPT holdouts will sign the treaty and accept IAEA safeguards on all their facilities. The emergence of non-NPT suppliers will make it harder to control the export of weapons-related nuclear technology. Even strengthening safeguards and export controls and minimizing the momentum toward plutonium recycling would not stop the drift toward a world of de facto weapons states.

The nuclear-weapons states, especially the United States and Soviet Union, need to take action to end the arms race, as Article VI of the NPT stipulates. They should, for example, agree to a complete test ban and substantial reductions in their nuclear arsenals.

Of course, such measures would not automatically reduce other states' incentives to acquire nuclear weapons, but they would show that the superpowers are not just advocating water and drinking wine. This would create a climate more conducive to curtailing nuclear proliferation and breathe new life into the NPT. Actions by the superpowers to end the arms race would influence the debate within governments, elite groups, and the public of other nations about the desirability of acquiring nuclear weapons and relying on them for national security. While a complete test ban would not prevent proliferation of simple fission bombs, it could hinder development of more advanced designs such as "low-yield" tactical warheads. Because the use of these weapons might be more easily rationalized, they are more dangerous than ordinary fission bombs that could destroy cities.

Although most non-weapons states strongly support the current non-proliferation consensus, it will remain fragile as long as the perception persists that the superpowers' primary motive for trying to prevent the spread of nuclear weapons is to maintain geopolitical dominance. True, the world will face a serious threat if nuclear weapons proliferate to other countries, particularly those that are unstable or undemocratic. But dwelling on the possibility that certain states may behave irresponsibly is paternalistic. The fact is that nuclear weapons are dangerous, period. Taking significant steps to end the arms race would show that we recognize as much. □

Reconstructing Central Park, and Space Shuttle Redux

Renewing an Urban Landscape

Rebuilding Central Park
by Elizabeth Barlow Rogers
M.I.T. Press, $27.50

Reviewed by Thomas Frick

Manhattan Island is one of those places that have the resonance of a double life. On the first level, it exists in its purely physical form. But on another level, it is a landscape and cityscape as much mythical as real. It has been dissected and interpreted in literature, theatre, and film for well over a century until there is no part that hasn't acquired a special glow.

Rebuilding Central Park, with Elizabeth Barlow Rogers as principal author, continues this tradition. The book—a blueprint for restoring and managing Central Park, at the center of Manhattan—is the result of a five-year investigation by the Office of the Central Park Administrator that involved sociologists, hydrologists, botanists, wildlife specialists, engineers, soil scientists, historians, landscape architects, traffic analysts, and others. It is the most comprehensive study of its kind and the first to concentrate on the curatorship of a *landscape*—a fragile entity that is much more than the sum of its parts.

One of the pleasures of the book, aside from its practical importance, is its section-by-section survey of the history and present condition of the park's 843 acres. Each section has its traditional name—Sheep Meadow, the Meer, Strawberry Fields, the Southwest Corner, the Ramble—and each has its own problems and personality. Through the book, which includes many attractive maps and quirky and interesting photos both old and new, the sections come to seem like a federation of tiny countries.

The creation of Central Park was a monumental feat of engineering and artifice. The park's commissioners awarded a prize of $2,000 for its design in 1858 to Frederick Law Olmsted, who went on to become the nation's premier landscape architect, and Calvert Vaux, an English-trained architect and friend. Olmsted had been reluctant to enter the competition at first, since his nominal superior, the park's chief engineer, was also doing so. But his boss's contemptuous indifference and



Vaux's continued entreaties finally persuaded him.

The award marked the beginning of almost 20 years of transformative labor. According to Rogers and her colleagues, "Working with pick axes, shovels, horse-drawn carts, and 20,800 barrels of gunpowder, an army of laborers manipulated an estimated 4,825,000 cubic yards of earth and rock. This included about 700,000 cubic yards of imported topsoil, imported to supplement the Park's thin glacial till." Indeed, a photograph of the pre-park site shows a barren swath of sharp rocks and stubbly "swampland occupied by squatters, goats, and a bone-boiling works." The result of this intensive labor, during which every square foot of the park was worked over by hand, was to create an immense illusion of "naturalism"—an idealized Romantic landscape where a city dweller could actually lose sight of the city. This effect was retained until the twenties and thirties, when skyscrapers began lining the park with their cliff faces.

Vandalism Takes Its Toll

Fascinating pages in *Rebuilding Central Park* concern the history and ideology of the park's many uses. The park's best friends have always divided into two groups: the "preservationists," who have wanted to keep the space as it was originally designed, and the "progressivists," who have wanted to improve it in multifarious ways. Such proposals, made from the turn of the century through 1965, have included airplane fields to housing projects, radio towers to a giant Buddha. A sketch of the alterations proves the authors' point that "in retrospect, these proposed interventions can be seen as having seldom been wise, even when they were well-intentioned. Had they all been implemented, the Park would have long ago been obliterated altogether." As Will Rogers said of real estate, "They ain't makin' any more of it." In this case, the most "conservative" position, according to the authors, has turned out to be the most progressive.

Of course, the park *has* changed over the years. The rise of organized recreation in the early twentieth century led the park's managers to set aside more and more plots for permanent sports facilities, courts, and fields. In particular, Robert Moses, New York City parks commissioner for 26 years, used his powerful personality and wide influence to bring his preferences—solid though whimsically ornamental architecture and a "prettified nature" approach to landscaping—to bear. One of his most controversial installations was the Wollman Skating Rink, which writer Lewis Mumford and others thought a heavy-handed eyesore. Yet in practical terms the rink has been a great success, remaining one of the most popular recreational sites in New York City.

The 1960s and their aftermath were a crucial turning point in the park's history. The budget crises of the Lindsay and Beame administrations resulted in a prolonged period of decay and degeneration (whose ultimate remediation is the main purpose of the book). One by one bathrooms were closed, fountains dried up, drains became clogged. Vandalism took its toll as only emergency repairs were undertaken. Benches rotted, lawns turned to dirt, stairways crumbled.

At the same time, mass events and renewed individual activism—protest marches, rock concerts, and other more spontaneous performances—made quite clear the fundamental importance of this free space in integrating public expression and private enjoyment in the dialogue of urban life. Jogging, bicycle riding, roller

ILLUSTRATIONS: MARY ANN SMITH

Proposals to "improve" the park have included airplane fields to housing projects, radio towers to a giant Buddha.

skating, cross-country skiing, and other new forms of park use also developed massive followings. A 1982 survey conducted as part of the research for this book even included "drugs/deviance" as a category of park use along with "reading," "thinking," "people watching," and "zoo." Eighty percent of the park's users were found to enjoy it primarily for "passive" and "unorganized" activities. The survey also showed that increased use of the park by handicapped people has reinforced the need for "barrier-free facilities." The authors found that efforts to set aside large portions of the park for specific uses had not taken such informal needs into account.

Aside from addressing issues of use and public policy, the study's authors mapped all the park's physical systems on computer. Because the updating of diagrams showing underground pipes, valves, and catch-basins was abandoned in the 1960s, this information has been compiled in one place for the first time. The researchers also inventoried the park's 24,000 trees and recommended new plantings after comparing the survey with earlier counts. They found that the park has too many trees of too few varieties. Careful thinning is needed to recreate the illusion of borderless meadows. Study participants also drew charts of pedestrian traffic to take note of what are delightfully termed "desire lines"—paths actually made by walkers as opposed to those created on the drawing board.

This book could make a difference in urban life everywhere by providing an example of thoughtful curatorship of isolated landscapes. A reader can only hope that the result of five years of deliberation and information gathering will not become just another library artifact, shelved and forgotten. Free space designed with all the people in mind can help make the difference between an empire city that expands along the lines of least resistance and one that remains a center of true culture. So far there are no plans to bring the study's recommendations to fruition. Doing so will take vision and dedication, a coupling seemingly in short supply in political life these days.

THOMAS FRICK writes for Art in America *and other publications.*



Space Shuttle Redux

Challenger: A Major Malfunction
By Malcolm McConnell
Doubleday, $17.95

Prescription for Disaster
By Joseph J. Trento
Crown, $18.95

Reviewed by Robert G. Nichols

In the minds of most people, the space program is a technological endeavor, a nuts-and-bolts process. Engineers design equipment to carry humans safely through outer space. Communication satellites relay information from one part of the planet to another. Spidery interplanetary probes startle scientist and layperson alike with glimpses of distant, alien worlds.

It's all too easy to forget that political expediency, more often than not, is the real driver behind efforts to explore and exploit outer space. The political forces and controversies that led to the *Challenger* explosion are the focus of two recent books: *Challenger: A Major Malfunction* by Malcolm McConnell and *Prescription for Disaster* by Joseph J. Trento. Each book, while going over some familiar ground, provides interesting and occasionally revealing insights into the events that led up to the sudden end of shuttle flight 51-L.

McConnell's main goal in *A Major Malfunction* is to apportion blame for the disaster, and the result is that he takes aim at nearly everyone in and out of the space program. He blames NASA for letting cost instead of crew safety become a major consideration in the design and operation of the shuttle fleet. He argues that Rockwell International pulled a couple of fast ones to become the prime contractor for the shuttle, while Utah-based Morton Thiokol was chosen to build the solid rocket boosters because NASA administrator James Fletcher also hails from that state. McConnell makes the now familiar point that the top brass at the Marshall Space Flight Center brushed aside known problems with the booster so that launch schedules would not slip. He even makes a half-hearted effort to blame the news media for not uncovering problems with the shuttle program sooner.

McConnell sees the roots of these problems in events at the end of the Apollo program, when NASA was casting about for a new megaproject to keep its legions of engineers and scientists busy. After much political maneuvering and compromise, Congress gave NASA the go-ahead to build the shuttle fleet. Yet the agency agreed to build the orbiters with far too little funding, so it simply lowered its standards. Vehicles were designed without escape systems for the crew. Solid rocket boosters were chosen because they were cheaper (although they were considered reliable at the time). And there were no funds for a test vehicle: the shuttle had to be astronaut-rated on its first flight.

To maintain a heavy launch schedule, Kennedy Space Center personnel had to work overtime for weeks on end, increasing the chance for error. And errors did occur. Some were relatively minor, such as when equipment accidentally dropped on the *Discovery*, requiring costly repairs and delaying a launch for several weeks. Other mistakes, such as when a computer operator inadvertently drained 20 percent of the shuttle's fuel just before a launch, could have had tragic results. The error was discovered only after the launch was scrubbed for another reason.

There was never enough money to properly equip all four orbiters. When the *Columbia* returned to Edwards Air Force Base in California before *Challenger*'s last

One of Challenger's five main computers was hurriedly installed while the craft was on the launch pad.

flight, technicians had to swarm over it and strip major parts, including one of its five main computers. This equipment was immediately flown to Cape Canaveral and hurriedly installed while *Challenger* was on the launch pad—not exactly under ideal conditions.

For all McConnell's promises to reveal the truth behind the accident, most of his points have already been covered by the Rogers commission and in the press. He also fails to identify his sources when he does provide new information. For example, he quotes a NASA official as believing that beating the Soviets in establishing a shuttle program would impress "the American public and their representatives in Congress." However, McConnell neglects to tell us who said this and whether this person represented the views of the agency's top brass.

McConnell also shows how a journalist can find duplicity wherever he looks. For instance, he gives the impression that NASA tries hard to curtail press access to key personnel, complaining that reporters cannot drive up and "buttonhole" people involved with flight operations. However, these employees have to focus on the launch—the only way to ensure safety is to have them schedule interviews through the public-affairs office.

Top Management Blunders

In *Prescription for Disaster,* Joseph Trento traces the history of the manned space effort from the perspective of top management, arguing that policy changes at the highest levels allowed the *Challenger* accident to happen. He takes readers back to the Eisenhower administration, when the president's insistence on keeping the "military-industrial complex" at bay may have done much to maintain the independence of the civilian space agency.

Trento maintains that, in contrast to the shuttle era, crew safety was a key concern of the early space program. Safety was such a major issue that when von Braun insisted on additional tests for the Mercury Redstone booster, the Soviets became the first to send an astronaut into space.

Trento shows that crew safety, especially during a mission's extremely hazardous launch phase, remained a concern throughout the Gemini and Apollo programs. According to Robert Gilruth, one-time head of the Johnson Space Center, no piece of hardware received more attention than the escape systems that would jettison the shuttle's astronauts during an emergency.

Yet the author seems to have overlooked the disasters that did occur during the Apollo program. Three men died in the *Apollo 1* fire—a tragedy that could have been averted had the capsule been designed with proper safeguards. Then there was the near-tragedy of *Apollo 13* in 1970, when hasty work on the launch pad almost marooned a crew in space when an oxygen tank exploded.

Presidents Kennedy and Johnson gave the space agency the political clout it needed to push through budget requests. When NASA administrator James Webb wanted to know how much the moon program would cost, his managers came up with a figure of $10 billion to $13 billion. Webb then asked Congress for $20 billion—and got it. Today such a "fudge factor" would never withstand the scrutiny of a budget-conscious Congress that funds the space program only reluctantly.

The agency's fortunes began to change when Nixon took office at the height of the Apollo program. According to Trento, Nixon distrusted the agency because its achievements were so closely associated with Kennedy. He speculates that Nixon might have canceled the manned space program outright if not for its grand success and broad public support.

To regain political support, administrator Tom Paine came up with a space shuttle that would serve the needs of more than one agency. Instead of building the best vehicle that engineers could devise, NASA had to settle for one that met air force specifications to gain much-needed clout from the Pentagon. Problems continued under President Carter, who wanted to kill the shuttle because of cost overruns and development snafus, according to top NASA official Hans Mark.

In response to these problems, agency employees became more involved with political affairs at the expense of technical expertise, until NASA found itself with an administrator with little experience during the Reagan administration. William Graham, a consultant to the Pentagon recommended by science advisor George A. Keyworth II, was appointed deputy administrator over the objections of NASA head James Beggs. Graham became the agency's head when Beggs took a leave of absence. Instead of being at Cape Canaveral during *Challenger*'s fateful flight—the usual post for the top official—Graham was in Washington mending political fences.

Rush Job

Although Trento's recounting of these events is valuable, he makes a number of factual errors that indicate a lack of knowledge of the technical details of space flight. For instance, he maintains that the Soviets didn't have the capability in the mid-sixties to "send men on a successful circumlunar flight." Not true: the Soviets came very close to beating the *Apollo 8* crew to the moon in 1968.

Both these books suffer from a similar flaw: they were rushed out in time for the first anniversary of the *Challenger* accident. The results are evident in missing information. Trento did not interview the rank and file at space centers outside Washington, for example, an effort that would have yielded more insight into how policy changes at NASA's top levels affected people in the field.

Although neither book is the definitive study of the events leading to the *Challenger* tragedy, both offer important lessons on how to avoid similar disasters in future space programs. The authors show that problems arise when politics intrudes into efforts to design and operate spacecraft. It's one thing to oversee NASA but another to interfere with its functioning. Unfortunately, this is just what is happening with the space station. According to one NASA official, "Everybody in Washington thinks they know how to build a station," and each is coming up with his or her own specifications for its design. Politicians should heed the lessons in *A Major Malfuntion* and *Prescription for Disaster:* let NASA go about its business of running the nation's space effort without political interference.

ROBERT G. NICHOLS, a free-lance writer specializing in space, formerly worked as a public-information officer at the Johnson Space Center.

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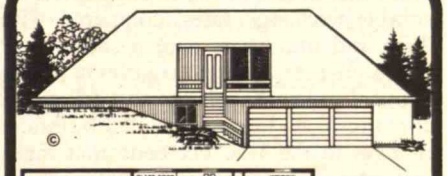
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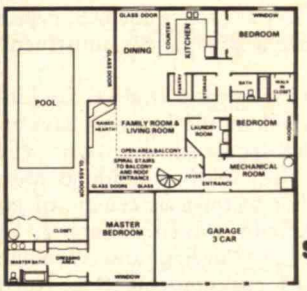
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Turning Up the Heat On Real Estate and Cancer

The Rising Sun on U.S. Real Estate

The Japanese are coming. Indeed, they're already here.

"Substantial and sustained Japanese investment in U.S. real estate is an almost irreversible trend," say Russell C. Lindner and Edward L. Monahan, Jr., in a best-selling report from the M.I.T. Center for Real Estate Development. Already, say Lindner and Monahan, "the diversity and depth of Japanese real estate activities in the United States are greater than is generally understood."

Both received master's degrees from the M.I.T. center late last year, and they're now active in the real estate industry, Lindner in Washington, D.C., and Monahan in northeastern Massachusetts.

Several factors motivate Japanese real estate investment in the United States: favorable exchange rates, compared with three and four years ago; a shortage of similar investment opportunities in Japan; political pressure in Japan to address the chronic U.S.-Japan trade imbalance; changes in the U.S. tax code that make real estate less attractive for U.S. capital; and a weakening Japanese construction market.

For their investments to date, say Lindner and Monahan, the Japanese have preferred large-scale downtown office buildings. Most of their holdings are in areas familiar to them as centers of Japanese-American influence, such as San Francisco, Los Angeles, and Honolulu. But now the focus is moving to the Northeast Corridor. New York has special appeal for many Japanese, write Lindner and Monahan: "they believe it epitomizes America and American real estate." Perhaps the ultimate high, a Mitsubishi officer told Lindner and Monahan, would be to own a major New York skyscraper.

Estimates of Japanese real estate investments vary; no one knows for sure. *Engineering News-Record* put 1985 commitments at $1.7 billion and estimates that in 1986 the Japanese invested $4 billion.

Should Americans worry? No, write Lindner and Monahan; better they take advantage of Japan's interest. "An increasing Japanese presence in the U.S. marketplace will present great opportunities for almost all kinds of U.S. real estate players," they write—salespeople, investors, and architects of joint ventures.



New York's Algonquin Hotel is among recent Japanese acquisitions; so is the 666 Fifth Avenue building. For the Japanese, "New York epitomizes American real estate," says an M.I.T. study.

"The rising sun will shine a most favorable light on the American real estate business."

Building Studies

A new Center for Advanced Construction Technology will be supported at M.I.T. by a $15 million grant from the U.S. Army, whose Corps of Engineers is one the world's major constructors. A broad program of research in areas including engineering, materials handling, and the application of computers and automation is anticipated to explore new technology and materials for both permanent and portable structures. Work will be conducted within the Center for Construction Research and Education in the Department of Civil Engineering, says David H. Marks, head.

Hazardous Waste

A "gridlock of conflicts" now blocks progress toward rational use and management of hazardous chemicals, says Daniel Roos, director of the M.I.T. Center for Technology, Policy, and Industrial Development. We cannot agree on national policies, on the siting of local waste facilities, or on a scientific basis for action, he explains.

To break the deadlock, Roos's center is organizing a 10-year, $10 million research and teaching program on hazardous substances management, and Dow Chemical Co. has become the first of what is hoped will be 10 major corporate sponsors.

Killing Cancer with Heat

Hyperthermia—selective heating of parts of the body—is likely to emerge as "a primary mode of cancer therapy, as important as surgery, radiation, or drugs," says Padmakar P. Lele, professor of experimental medicine in the M.I.T. Department of Mechanical Engineering and in the Harvard-M.I.T. Program in Health Sciences and Technology. He has made the field a major professional interest for a quarter of a century.

Hyperthermia works against cancer, explains Lele, because the reproducing cells in the tumor are more sensitive to injury from heat than the stable normal cells of the tissues.

To create heat, Lele uses one or more beams of ultrasound—sound waves at frequencies higher than the ear can detect. The ultrasound causes vibrations in body tissues, resulting in heat from friction. To avoid damaging healthy tissue, Lele focuses the ultrasound beam(s) so that they converge on the tumor.

Hyperthermia is especially effective, says Lele, when used in conjunction with other therapies, such as x-rays and chemotherapy. Heat affects cancer cells that x-rays cannot destroy, and vice versa. Heat also increases the effect of chemotherapy drugs within the tumor.

PHOTO: BETTMANN NEWSPHOTOS

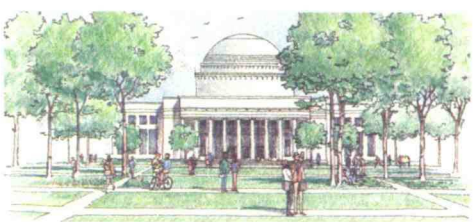


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Jackson Building, Occupancy July, 1987



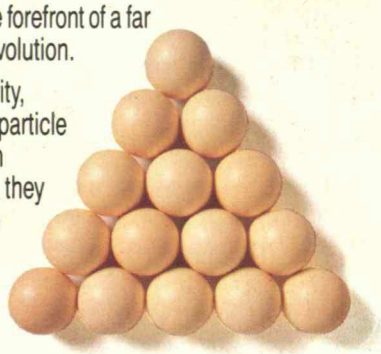
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